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INDUSTRIAL ENGINEERING

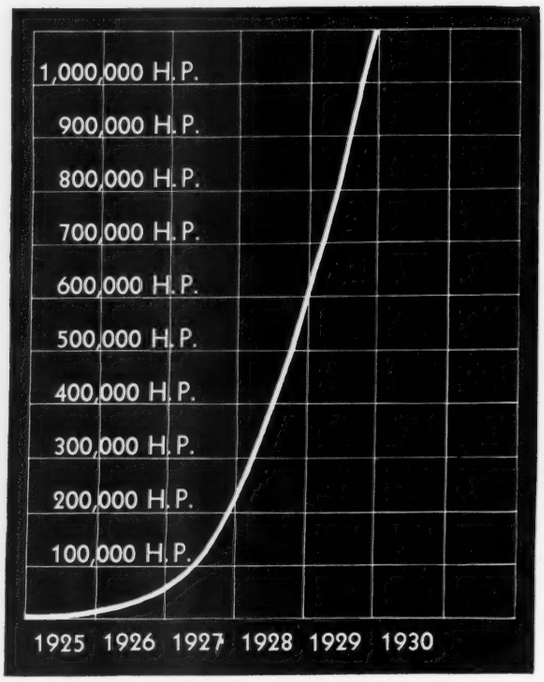
PLANT ENGINEERING IN INDUSTRY

A McGraw-Hill Publication

For Cover Story see page 127

MARCH, 1930

The curve shows the truly amazing manner in which Texrope Drives have leaped into the limelight. Since 1926 there has been a tremendous increase in Texrope sales *each year*. The curve is based on the total horsepower of the drives sold. Similar curves, based on actual number of drives or upon sales in dollars, show the same result . . . . an ever-increasing, and remarkably large, demand for Texrope.



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Editorial Contents for March, 1930

If Your Buildings Are Not All They Should Be..... 115

New Building?..... 116
By WM. E. CAMP

What Price Solder?..... 120
By CHARLES D. ELLIOTT

What Is Safe Temperature for Spray Booth Lamps?.... 122

Around the Works.....123, 131, 144, 148

Editorials 124

Let There Be Enough Light..... 126

Synchronous Motors for Heavy Drives..... 128
By E. G. PETERSON

Questions and Answers..... 133

Electric Furnaces 136
By E. L. HEISLER, JR.

Plant Engineers' Forum..... 139

Bearings for Power Transmission..... 145
By WILLIAM STANIAR

Modernizing Old Motor Windings..... 149
By A. C. ROE

Equipment News and Trade Literature..... 152

Industrial Engineering's Data Sheets..... 161

Management Congress and Equipment Exposition..... 163

Every plant engineer who attended the Maintenance session of the National Management Congress on March 4 will want to read the addresses that he heard. The engineers not fortunate enough to have been at the meeting *must* read them to get in step with what is going on. Beginning on page 163, an account of the doings, and the three papers.

Now is the time to put up new buildings and to rehabilitate the old. What should be the participation of the plant engineer? How does providing for low-cost maintenance enter the picture? Starting on page 116 is Wm. E. Camp's story on the part played by the plant engineer in a specific case.

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INDUSTRIAL ENGINEERING

PLANT ENGINEERING IN INDUSTRY

A McGraw-Hill Publication, founded 1882

Volume 88 CHICAGO, MARCH, 1930 *Number 3*

If your buildings are not all they should be—

. . . When construction activities are at their lowest is the time to build. Right now happens to be such a time. The causes of inactivity are well known: a natural seasonal slump; the use for speculation of money that should have gone into industrial investment; hesitancy because of the stockmarket crash.

. . . Major new industrial construction is the business of the plant engineer, in that he should help in the design from the standpoint of economical plant operation. Minor construction, of course, is a part of his function. So are repair and remodeling.

. . . Periods of intense production are coming. The summer increase in building is approaching. Good men now available will have all they can do then. Labor shortage and higher commodity prices are ahead when the construction industry is in full swing.

. . . The financial stage is set. A building conference, organized as a part of the general program of business stabilization, is inviting the co-operation of banks, mortgage companies, and building and loan associations in financing meritorious construction projects.

* * * *

. . . What are the things to be done?

. . . They are legion, when a new building is to be erected. Here are a few: What shall be the shape of the building? The number of stories? To be constructed of what materials? Type of windows? Relation to future building? What provisions for loading? How shall the power lines and wiring be arranged? How illuminate? How heat? What are the elevator problems? How about drinking water? What shall be the influence of materials handling equipment? Where shall the plant service equipment be located?*

. . . For existing buildings it may be advisable to erect additions to facilitate manufacturing operations, simplify materials handling problems, and improve working conditions; enlarge doorways and passageways; remove walls and partitions; make extensive repairs.

* * * *

. . . In preparing now for cheaper production in the era of prosperity that is ahead the housing of equipment is quite as important as the equipment itself. Obviously, there is something to be gained by taking advantage of the existing opportunity for carrying out building improvements economically.

*These matters, and others, as they were considered in a specific case, are treated in the article beginning on the next page.

NEW BUILDING?

Let the Plant Engineer Help Design It

By WM. E. CAMP
Industrial Engineer
The Brown Instrument Company
Philadelphia, Pa.

Because the maintenance of buildings is a part of his job the Plant Engineer is vitally concerned with the mechanical and electrical features. It may, in fact, be necessary for him to make minor additions and changes in the equipment after the contractors have left.

THE Brown Instrument Company recently completed its second building operation in two years and the men who maintain the plant have been particularly fortunate in having full say in the specifications as they affected the plant engineering function.

The latest building is Tee-shaped, the cross bar being 215x60 ft. and the wing from its center 70x40 ft. Two stories and basement contain nearly 50,000 sq. ft. of usable space. The construction is re-inforced concrete flat slab, with monolithic floors. Steel windows fill the spaces between the columns except for brick curtain walls up to the sills. Walls are designed to carry two additional stories, so that the present slab under the roofing is a future finished third floor.

In giving details of some of the features of the building I do not have the thought that they are original or even unusual, but that they represent the choice of ourselves and of our architects as to equipment and methods available. They are working out as expected and may contain suggestions of value to other engineers.

To take advantage of all the land available the buildings now extend to the building line on all sides, interior courts or areas being left for light and air. This layout made necessary the placing of motor truck berths and loading platform wholly within the building on the first or ground level. Each truck berth is wide enough for two trucks and there are three berths closed off from the street by motor-operated, rolling, steel doors. The controls for the doors are located on the loading platform and over them are annunciators connected with bell buttons on the street side. In cold weather a truck can be admitted and the door closed again in front of it while loading or unloading. The motors and mechanisms require only periodic lubrication.

Truck slips and platform are partitioned off from the balance of the first floor area, are sprinklered, and are heated by a unit heater figured for a temperature of 50 deg. On the second floor above the truck slips are research laboratories with linoleum laid on the concrete floors. To minimize any possibility of cold floors in the laboratories, due to frequent opening of the large steel doors below, the ceiling of the truck area is covered by a double thickness of insulating material.

The building is so placed in relation to the older parts of the plant that the small wing is approximately in the geographical center of the entire plant; and here, in the basement, is located the plant service department.

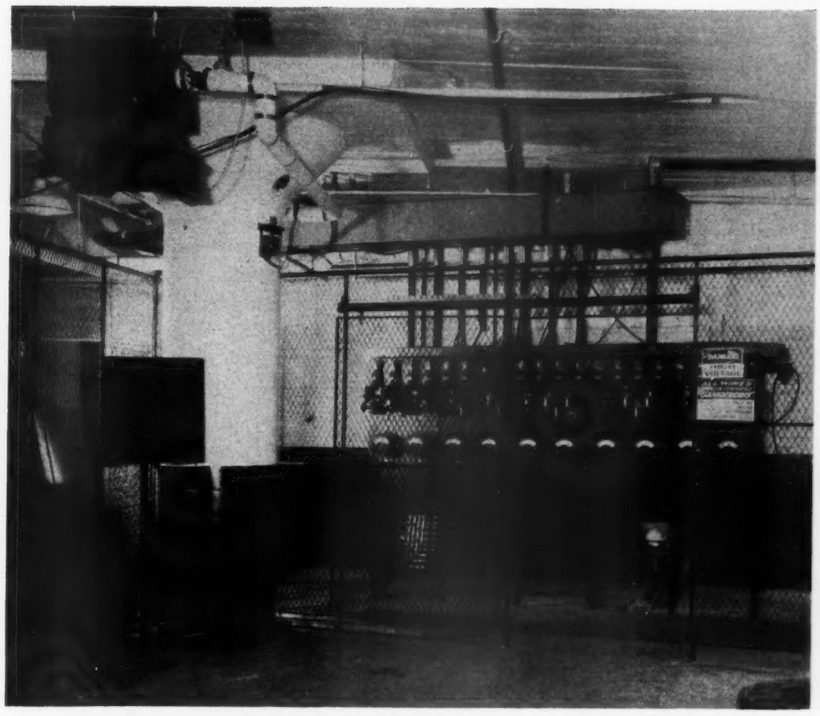
In the basement are the transformer room, electrical distribution center, motor-generator sets, air com-

A manufacturing department in the new building. Final assembly of flow meters, showing unit heaters. The rain water conductor, upper center, has a band painted on it near the ceiling. In this case the band is green in accordance with a color code to distinguish the various pipe lines.

pressors, hot water generator, and refrigerating machine. Here are, also, the millwright headquarters and the plant electrician's shop.

We purchase our power at 2,300 volts; it is brought through ducts underground and under the basement floor to the transformer room and from there to the main switchboard. From the main board the power and light lines radiate to panel boards in each department.

The switchboard contains two lighting panels and three power panels for feeders to various sections of the building. Air-type circuit breakers are equipped with overload, inverse-time-limit, undervoltage, and non-closable on overload features. Ammeters are placed under the circuit breakers on each panel. There is also a panel on which are mounted a power factor meter and recording voltmeter registering voltage on both phases of the two-phase circuit.



Main distribution panel. The wiring has not been completed. A unit heater, of the type used in the basement, is shown in the upper left corner.

Wiring

Wiring, at first, seemed to present a most complicated problem. The manufacture of pyrometers, electric flow meters, and other industrial instruments requires a great number of circuits of different characteristics. We have 220- and 110-volt, a.c., 60-cycle and 25-cycle, and 22- and 110-volt, d.c. current. In addition we have lower potential d.c. circuits for time system, call bells, and a resistance thermometer system which tells, in the boiler room, the temperature of the various departments throughout the plant. There is also the telephone wiring to be provided for. And I have not mentioned isolated, variable-frequency outfits, voltage regulators, and phase transformers.

The general plan followed was to have the lighting and fan circuits concealed in the concrete by the electrical contractor and to have our own electricians install the power lines. The general illumination was easily planned by the architect as there was no problem special to our plant. Concealed lines in concrete are less costly to install than are exposed lines because the conduit can be run by the shortest route from outlet to outlet; parallel lines and right angle bends are unnecessary. But the plan of running our power and other circuits in exposed conduit left us free to make changes in plans as the building progressed without the red tape of authorizations for extras and credits. While a completely concealed system might present a better appearance, one must count on frequent changes and new requirements, so that the initial appearance would soon be marred by an outcropping of exposed lines.

A general departmental layout was completed before the start of operations so that sleeves could be installed in walls and floor slabs for the principal power lines. In addition to these sleeves the specifications called for two 4-in. pipe sleeves at every column in the building for future use. The 4-in. openings are being used, as occasion requires, for telephone and time system and for piping such as compressed air and gas where installed by our own men.

Exceptions to the general wiring plan were made in the case of power lines for fixed equipment such as the motor-operated doors, elevator, and heating units, which lines were run in the concrete. Exception was made, also, in running under-floor duct in an office section to carry lines for dictaphones and telephones. With concealed lighting circuits this leaves the office section entirely free of exposed conduit.

In connection with the placing of under-floor duct a sketch was made showing every practical desk layout which might be used and the parallel lines of duct then imposed on the sketch so that they would run under desks rather than aisles. The duct is in the concrete floor and the floor is covered with linoleum. It is so constructed that it is possible to drill into the floor and insert an outlet every 24 in. of its length. Outlets are inserted only under desks to be served and the system is invisible but flexible.

The general illumination throughout is designed with four 150-watt outlets to each 20x20-ft. bay. Fixtures in the factory portion are of the glass and steel diffusing type and inclosing globes are used in the office. The lighting fixtures were purchased and hung by our own electricians. A separate circuit of fixtures for watchmen is controlled by 3-and 4-way switches.

Heating

Heating of the building is accomplished by unit heaters suspended from the ceiling, the fans being controlled by thermostats on nearby columns. To give greater opportunity for adjustment to meet the local conditions, a heater with a two-speed, condenser-type motor was chosen. The units are suspended on unions so that they can be swung on a vertical axis for further adjustment. Switches for the heaters require a key for operation, to prevent unauthorized starting, stopping, or changing of speed.

Levels are such that the vertical, fan-type heater used on the first and

second floors could not be used in the basement, because the return would be brought too low to feed back to the boiler room. In the basement we used a heater which is horizontal, i.e., the motor shaft is vertical and the radiator is above fan and motor, which brings the return from the radiator nearer the ceiling and high enough for grading to the boiler room.

The office portion of the building is heated by a combination of direct radiation and ventilating units which take in fresh air, filter it, heat it, and project it from under the windows toward the ceiling. A sufficient number and size of ventilating units were installed to provide for proper air changing, and direct radiation installed is sufficient to make up the difference between the total heat loss and the heat supplied by the ventilating units.

The heating system is vacuum-steam generated by oil-fired boilers, additional boiler capacity having been added to take care of the new building. The oil burners are fully automatic, rotary burners controlled by the steam pressure, and burning 19-23-gravity fuel oil stored in a 6,000-gal. tank under the concrete floor of the boiler room. Liquid level gage for the tank, stack temperature recorder, and the resistance thermometer mentioned above are of our own manufacture.

Heating and ventilating of the enameling department is accomplished by a unit which takes in fresh air through a filter, heats it, and blows it into the room. The capacity of the fan and duct has been figured to make up the loss of air through spray hoods and ovens. In the enameling department in the old building we were troubled with down drafts in the ovens, caused by the exhausting of the air in the room by the spray booths. Opening the windows overcame the difficulty but admitted dust which spoiled the work. In the new department the entire air supply is filtered to remove dust. In the warm months the radiator of the unit will not be in operation and it is hoped that, if it is necessary to open windows at all, the circulation will be from the unit toward and out through the windows.

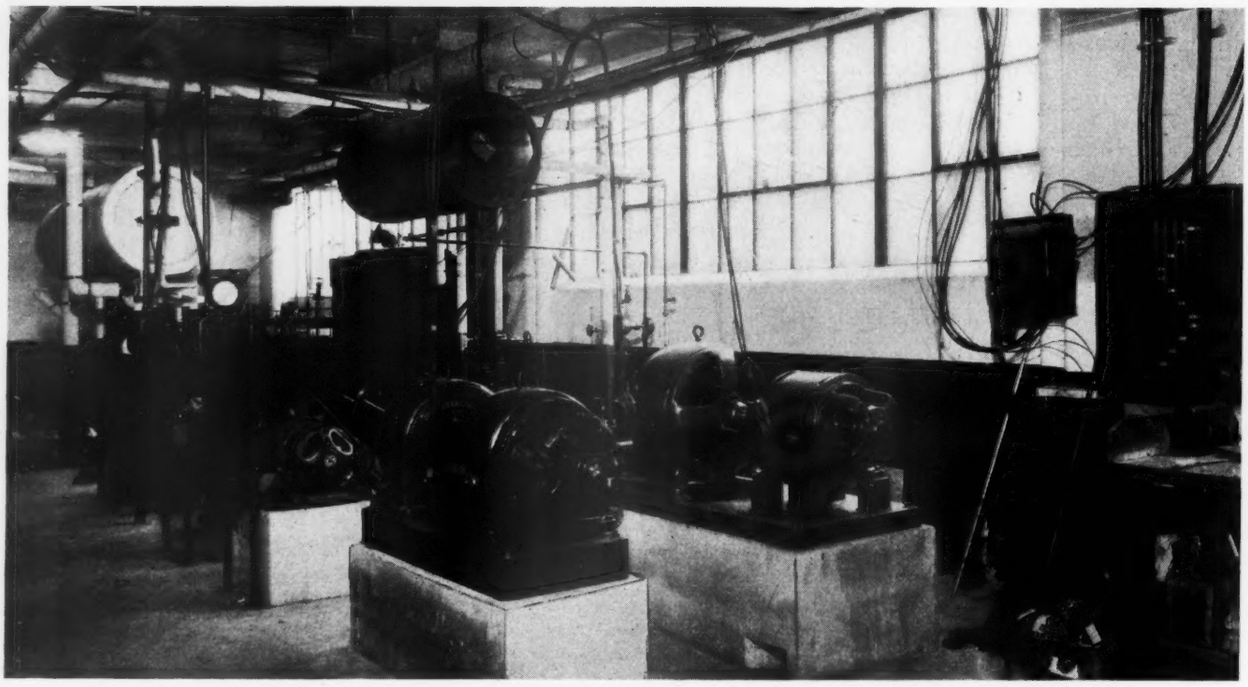
Material Flow Charts Determine Building Layout

The first step in planning the building was a study of the flow of material in process and each product was traced from receiving platform to shipping door. The layout of the building and its departments resulted from flow charts, but also provisions for material handling equipment could be intelligently placed. A chute was installed for sliding raw material from the receiving room inspection to the raw material store room. Future chutes and conveyors are provided for by leaving in the floors loose slabs which can be removed to admit conveyor lines. At one location tapped inserts were placed in the ceiling to carry a future monorail line. It is easier to place inserts in the forms before pouring the floor than it is to drill the concrete and the resulting job is more secure. Small, removable slabs in the floors are easily made by the builder, the only requirements being that they be located so that they do not interfere with reinforcing rods and do not weaken the structure.

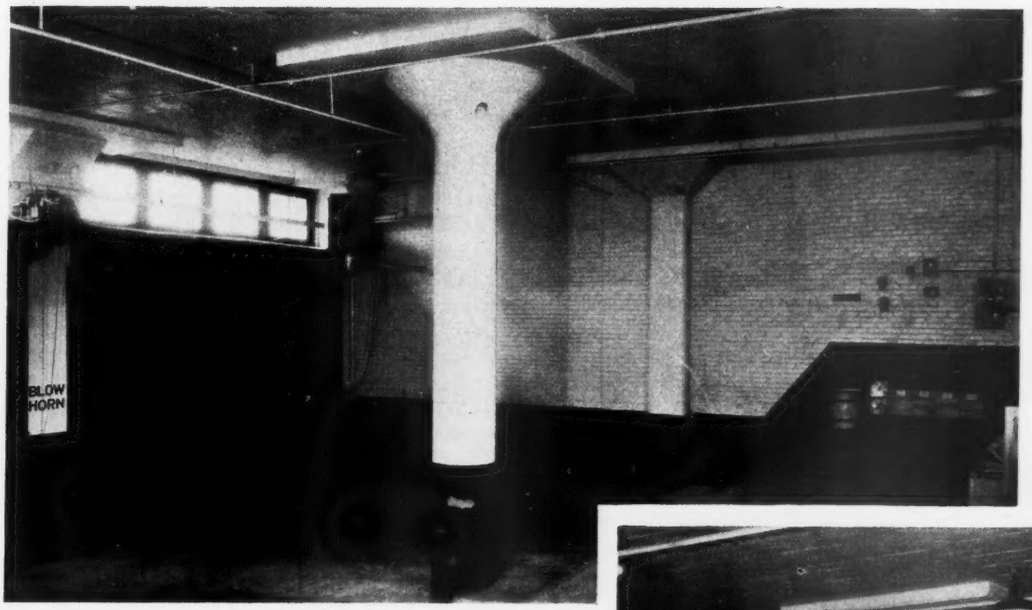
Elevators

A 4,000-lb. elevator of the "push-button" type serves the new building. It can be used efficiently either with or without a regular operator. At the present time we license certain individuals to operate our elevators; they are instructed and given a formal card permitting them to operate. The "push-button" elevator has buttons at landings, i.e., on the "hall" side, which will bring the car to the floor and also buttons for "up" and "down" in the car. Both hall and car buttons must be held down continuously to maintain motion of the car. Elevator doors are equipped with contacts, of course, so that all doors on the shaft must be closed before the car will move. Should it be advisable to have a regular operator on the car, there is a switch in the car which throws out the hall buttons.

All ceilings in the entire building contain 7/8-in. tapped inserts every four feet both ways for supporting



Plant service equipment in the plant department. The picture was made immediately after installation of the motor-generator sets and the wiring shown is temporary.



One end of the truck berth and loading platform showing one of the door-operating mechanisms at the extreme left and door controls at the right. The ceiling is covered with insulating material to prevent cold floors in the rooms above.

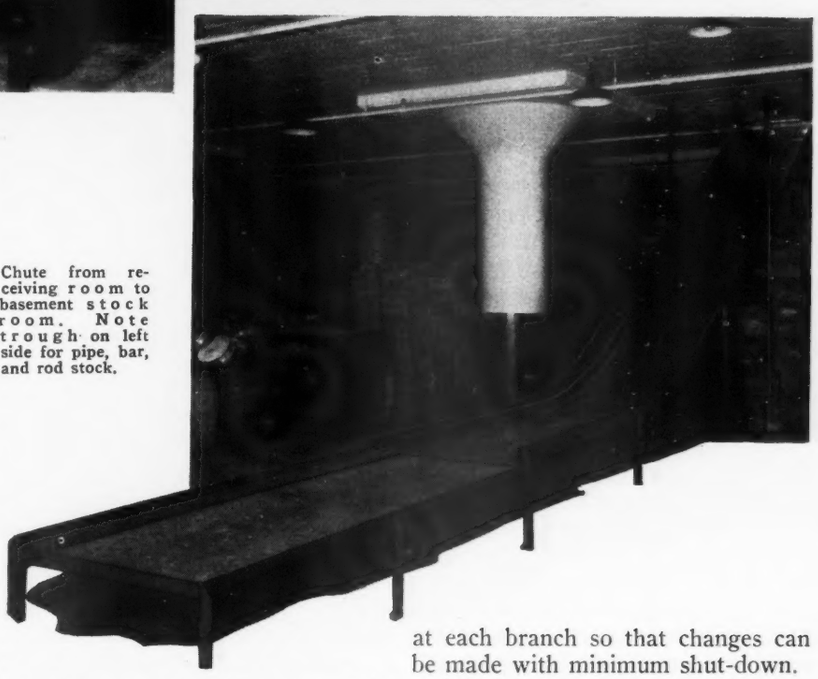
stringers, piping, or other equipment that must be hung from the ceiling.

Drinking water is circulated to bubblers throughout the old plant by a central ammonia machine. It was found that this machine did not have sufficient capacity for the eight fountains planned for the new building in addition to the old. We elected to install independent units with bubblers at four locations on the second floor and to drop a cork insulated line to bubblers directly under them on the first floor. Each unit has a motor-driven compressor and a storage tank, both inclosed in one cabinet with the bubbler on the front of the tank portion. The outlet to the fountain on the floor below is from the back of the tank. The units are entirely automatic in operation.

The system of independent units requires city water, drain, and electrical outlet at each location, but eliminates the circulating ice water piping which must be covered for its entire length. Perhaps the most important consideration is that the system is more flexible for future additions than is a central plant.

A "refrigerating machine" is mentioned in the enumeration, above, of equipment in the new plant service department. It should be explained that this is the machine which serves the older buildings and has been removed to the new location to place it with the other service equipment.

All doors in main passageways are fitted with glass panels at eye level to prevent collisions of pedestrians. This may seem a small point, but we found it advisable to install glass panels in doors in the old plant, and



Chute from receiving room to basement stock room. Note trough on left side for pipe, bar, and rod stock.

the point may as well be covered in specifications for new construction.

On the subject of doors, the city building code required one outside door for fire exit in a location in which we did not need an entrance or exit. For proper discipline we did not desire employees to go out that door; but it was not practical to station a watchman there, nor, being a fire door, was it possible to lock it from the inside. The problem was solved by placing a brass box with a glass front over the knob. The glass can be broken easily in case of fire.

Piping

Every plumbing fixture is fitted with a separate valve so that repairs can be made without interruption to the balance of the service. On the same principle, gas, compressed air, city water, and steam lines are valved at each branch so that changes can be made with minimum shut-down.

All piping in the building is identified by a color code. Instead of painting the piping for its entire length, however, bands 4 in. long were painted around each pipe 4 in. from where it enters or leaves a wall or ceiling. The band of color is on both sides of each partition wall so that a line can be traced from room to room. In addition, all valves and flanged fittings were painted in the code color to prevent turning the wrong valve or putting a wrench on the wrong fitting.

Woven wire partitions, 8 ft. high, are used where partitions are required between departments and around stock rooms.

We selected the style having wire to the floor because they were less expensive and also because the transparency is an incentive to better housekeeping within the enclosure.

What Price Solder?

By CHARLES D. ELLIOTT

According to these tests: A 32c solder cost 8c less— not 8c more— than a 24c solder

LARGE users of solder are familiar with the endless controversy between the personnel of the operating units and those responsible for the quality of solder provided for their use. A good mechanic likes to work with good material. An efficient engineering department will furnish that grade of material which, to it, seems best suited for the job.

Much has been said but little written, regarding solder, to serve as a guide to the proper grades for the various uses. Because our plant uses a considerable quantity of this material, it was thought advisable to analyze the different alloys and determine, if possible, their relative merits.

The products in the manufacture of which we use solder may be classed as light metal specialties. They include cans, boxes, lamps, etc., made up of tin plate and galvanized iron. On most of this work, smooth, unnoticeable seams are desirable. Little torch soldering is done, the soldering iron being generally used.

For the purpose of test and analysis, eight standard grades of solder were purchased from a reliable concern. Four of these grades, namely the "A" grades, contained only virgin metal, while the "B" grades contained some reworked metal. In Table I are shown the A.S.T.M. specifications for the eight grades, as well as our own laboratory analysis report.

This solder was furnished to competent mechanics and observations were made of the work done with each grade. Records were kept of the exact amount of each solder used, the number of units completed, elemental times per unit, and of the flowing and working properties of the different grades. The operators were ignorant as to the grade of solder they were using. The work was all clean and new and fairly typical of our product. Sufficient time readings and weights were tabulated to establish beyond doubt the figures from which the final analysis was made.

To set up, as accurately as possible, a rating of strength, 80 segments of lap seam were tested for the breaking point. There were 10 segments soldered with each of the eight grades of solder. The average breaking point per inch of seam for each grade is given in Table II. No. 1 is high and No. 8 low in the strength rating column.

The investigation was made on a production job, as was necessary to obtain uniform conditions. But, if the amount of solder used, the speed with which the work can be done, and the quality of the finished job are important considerations, the findings are applicable to any kind of soldering.

In order to determine that grade of solder most economical from the standpoint of quantity used, the amount of each grade used by the operator was carefully weighed and a quantity per unit established. Less solder of the better grades was used per unit because of the freer flowing qualities. Table III shows the results of this test. For purposes of computing actual costs, the amount of Grade A-1 used was designated as a Base Amount.

Seams soldered with Grades A-1 and B-1 were particularly clean and well alloyed. Those soldered with the poorer grades built up much heavier and were more noticeable, being grainy in appearance and often having air-holes and light leaks. This latter defect is a major one in our business, where light leakage will render useless a sensitized product.

Using the Base Amount, established in Table III, and applying the percentages found therein, the actual material cost per pound is shown in Table IV. In but two cases were the lower grades able to compete with the better grades of solders, i.e., Grades B-4, and B-3, and that because of the low actual costs per pound.

When using the better grades, operators were able to draw their irons farther down a seam without replenishing their solder supply; this because of the lower melting points and better flowing qualities. Of course there resulted a differential in the speed with which work could be accomplished. Table V gives a tabulation of the speeds with which seams were run on this work.

Analysis of time standards and amounts of solder necessary for a given amount of work showed that an operator used approximately one lb. of solder for each 60 min. on this class of work. For this analysis, the rate of pay for a first class solderer was figured at 65c per hr. By the use of higher grade solders, more work could be done in a shorter length of time than with the lower classes, establishing a compensating factor for the higher cost of the former.

Using one pound of Grade A-1 solder as a base amount for a cer-

tain unit of work, and applying the percentages of speeds for the various grades, the actual labor cost per pound is shown in Table VI. Due to the fact that time standards were in effect, governing the direct labor cost of this work, the time saving factor appeared much less important than if these standards had not been applied, the differential being too small to justify any revision, and too intangible to be satisfactorily explained to the operators. There was, however, a saving due to lower costs resulting from higher efficiency of direct labor, reduced burden charges, and faster material movement.

From the foregoing it is evident that economy in the purchase of solder should not be looked at from the standpoint of dollars and cents alone. The amount of solder necessary for a given amount of work, the speed with which a job can be accomplished, and the quality of the finished product also are prime factors to be considered.

Using the figures compiled during this investigation, actual solder costs, including additional labor and material used with the poorer grades, are shown in Table VII. Any of the eight grades of solder analyzed, with the exception of A-4, B-3 and B-4, might safely have been used in work of this nature. There seems no reason why these findings should not apply to any class of work except those in which solder is used to build up a form. Using the ratings from the various tables, the best solders from almost any standpoint may be selected from the summary, Table VIII.

Because of the fact that first cost had been too large a factor in the purchase of this material, our production department, previous to this investigation, had not been furnished the better grades. This policy was changed, due to the findings of this investigation. A check, covering a year, since the adoption of the new policy, shows that a real economy has been effected by the purchase of higher grade solder. The reduction in quantity used has been approximately 15 per cent and the same amount of work now requires but 92 per cent of the former labor hours.

Table I—SPECIFICATIONS OF SOLDER

	A.S.T.M. SPECIFICATIONS					LAB. ANALYSIS		
Grade No.	Per Cent Tin	Per Cent Lead	Per Cent (Max.) Antimony	Per Cent (Max.) Copper	Per Cent (Max.) Other Impurities	Per Cent Tin	Per Cent Lead	Pct. Antimony, Copper and Other Impurities
A-1	50.00	50.00	0.12	0.08	0.10	49.70	49.82	0.48
A-2	45.00	55.00	0.12	0.08	0.10	44.95	54.32	0.73
A-3	40.00	60.00	0.12	0.08	0.10	39.45	60.10	0.45
A-4	37.50	62.50	0.12	0.08	0.10	38.50	60.90	0.60
B-1	49.25	50.00	0.75	0.15	0.10	48.70	49.65	1.65
B-2	43.50	55.00	1.50	0.15	0.10	43.45	54.85	1.70
B-3	38.00	60.00	2.00	0.15	0.10	38.15	59.40	2.45
B-4	35.50	62.50	2.00	0.15	0.10	35.72	62.25	2.03

Table II—RELATIVE STRENGTHS

Grade No.	Breaking Load per In. of Lap Seam, Lb.	Strength Rating
A-1	324	1
A-2	242	4
A-3	111	7
A-4	109	8
B-1	287	2
B-2	262	3
B-3	214	5
B-4	184	6

Table III—QUANTITY FACTORS

Grade No.	Solder Used Per Unit, Oz.	Percentage Solder Used	Economy Rating
A-1	0.207	Base Amount	1
A-2	0.233	12.5 over Base	2
A-3	0.257	24.1 over Base	5
A-4	0.262	26.6 over Base	6
B-1	0.241	16.5 over Base	3
B-2	0.254	22.7 over Base	4
B-3	0.267	29.0 over Base	7
B-4	0.271	31.0 over Base	8

Table IV—RELATIVE MATERIAL COSTS

Grade No.	Quantity Factor		Price Per Lb.		Actual Solder Cost Per Unit	Material Cost Rating
A-1	1.000	×	$0.3194	=	$0.3194	2
A-2	1.125	×	0.2964	=	0.3335	5
A-3	1.241	×	0.2735	=	0.3394	7
A-4	1.266	×	0.2620	=	0.3317	4
B-1	1.165	×	0.2995	=	0.3489	8
B-2	1.227	×	0.2765	=	0.3393	6
B-3	1.290	×	0.2535	=	0.3270	3
B-4	1.310	×	0.2425	=	0.3177	1

Table V—LABOR FACTORS

Grade No.	Time Per Seam, Min.	Percentage Time Over Base	Speed Rating
A-1	0.312	Base Time	1
A-2	0.334	7.0 over Base	2
A-3	0.338	8.3 over Base	5
A-4	0.339	8.6 over Base	6
B-1	0.335	7.4 over Base	3
B-2	0.336	7.7 over Base	4
B-3	0.341	9.3 over Base	7
B-4	0.348	11.5 over Base	8

Table VI—RELATIVE LABOR COSTS

Grade No.	Labor Cost (Base)		Speed Percentages		Labor Cost Per Lb.	Labor Cost Rating
A-1	$0.65	×	100.0 (Base)	=	$0.650	1
A-2	0.65	×	107.0	=	0.696	2
A-3	0.65	×	108.3	=	0.704	5
A-4	0.65	×	108.6	=	0.706	6
B-1	0.65	×	107.4	=	0.698	3
B-2	0.65	×	107.7	=	0.700	4
B-3	0.65	×	109.3	=	0.710	7
B-4	0.65	×	111.5	=	0.725	8

Table VII—TOTAL COSTS

Grade No.	Base Cost		Added Labor Cost		Added Material Cost		Actual Cost Per Lb.	Actual Cost Rating
A-1	$0.3194	+	$0.000	+	$0.0000	=	$0.3194	1
A-2	0.2964	+	0.046	+	0.0371	=	0.3795	2
A-3	0.2735	+	0.054	+	0.0659	=	0.3934	7
A-4	0.2620	+	0.056	+	0.0697	=	0.3877	4
B-1	0.2995	+	0.048	+	0.0494	=	0.3969	8
B-2	0.2765	+	0.050	+	0.0628	=	0.3893	5
B-3	0.2535	+	0.060	+	0.0735	=	0.3870	3
B-4	0.2425	+	0.075	+	0.0752	=	0.3927	6

Table VIII—OVER-ALL EFFICIENCY

Grade No.	Strength	Economy	Speed	Material Cost	Labor Cost	Total Actual Cost	Total Rating
A-1	1	1	1	2	1	1	7
A-2	4	2	2	5	2	2	17
A-3	7	5	5	7	5	7	36
A-4	8	6	6	4	6	4	34
B-1	2	3	3	8	3	8	27
B-2	3	4	4	6	4	5	26
B-3	5	7	7	3	7	3	32
B-4	6	8	8	1	8	6	37

What Is Safe Temperature for Spray Booth Lamps?

Apropos of the above question, which appeared in *Industrial Engineering*, there was submitted the following article, by A. H. Nuckolls, published in Laboratories' Data, National Board of Fire Underwriters. The text is slightly condensed.

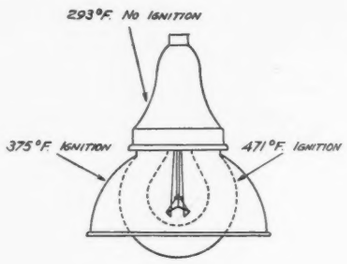
IN the lighting of spray booths there are two distinct phases of fire hazard to consider: The volatile liquid solvents, the vapors of which in admixture with air are flammable; and the non-volatile solids or residue, which is flammable and easily ignited under moderate heat. The residue and vapors, when present in the air as a mist or cloud, may under certain conditions where there is a source of ignition, offer a flash fire or explosion hazard.

Spraying operations are usually conducted in a booth or tunnel provided with a ventilating and a lighting system. If the lamps or fixtures are located inside the booth or tunnel, it will hardly be possible at all times to prevent the spray from striking them. The question arises, therefore, as to whether there is any real danger of ignition of the spray by lamps and fixtures. In order to obtain information on this and related questions, an investigation was planned to include the following:

First, a series of measurements to ascertain the maximum temperature attained by various parts of vapor-proof and mercury vapor lamps, fixtures, and auxiliaries. The measurements were made with thermocouples which had been accurately calibrated. During the tests the circuits were operated under the range of voltage permitted in such installations.

Second, a series of tests to determine the surface temperatures likely to cause ignition of spray residues such as are commonly used today. Although varnishes, enamels, and lacquers differ somewhat in composition as applied by the spray method, they all present a fire hazard that must be controlled, and in determining the general methods of control, the hazardous properties of the types commonly used should be taken as the basis.

Third, a series of actual spray tests in which the spray was applied directly to the lighted lamps, fixtures, and auxiliaries while in operation, by means of an ordinary type of spray gun.



Vapor-proof fixture.

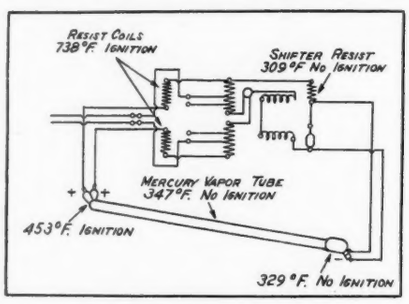
An inspection and study of spray booths, tunnels, and lighting arrangements in use at several plants in Detroit, Mich., were made in connection with this work.

The results of the foregoing series of measurements and tests showed that the temperatures attained by certain parts of mercury-vapor lamps and vapor-proof lamps are above the ignition point of ordinary spray residues, and that the spray may take fire when applied to the lamps under actual operating conditions. Ignition was obtained with the vapor-proof fixtures both on the outer glass globe and the reflector, and with the mercury-vapor lamps both at the anode bulbs of the tube and at the resistor coils of the auxiliary a.c. and d.c. types. Some of the data are presented graphically in the illustrations.

In the spray tests, flaming ignition of the residue deposited on the lamps occurred on the average of one in five trials. In a number of the tests flaming ignition occurred almost immediately upon application of the spray to the lamp or fixture. In some of the tests, flame appeared several minutes after the spray stream had been turned away from the lamp. In the other tests the deposited residue was decomposed (fuming off) without production of flame.

The subject was taken up with the manufacturers of electric fixtures, and it was the consensus of opinion that many mechanical difficulties would have to be overcome before the changes necessary in present designs of lamps or fixtures, to permit of their safe use inside of spray booths, could be made.

From our study of spray booths, of both the tunnel and hood types, in operation at Detroit and vicinity, it appears that the installation of the lighting units outside of the spray booths would work no hardship on the spraying industry. In some of the smaller refinishing plants some special arrangement of the lighting units may have to be devised but, in general, the best practical solution of the problem of minimizing the fire hazard of lighting spray booths is to have the lighting fixtures located outside the booths in a position where there is no possibility of the spray coming into contact with them. Auxiliaries of mercury-vapor lamps should be offset 10 ft. from the face of the booth. In this connection attention is called to the National Fire Protection Association's "Advance Publication on Revised Regulations on Paint Spraying and Spray Booths," and also Article 32, National Electric Code.



Mercury-vapor lamp, a.c. type.

A very satisfactory arrangement is to have booths or tunnels with side wall windows provided with wired glass, the lighting unit being mounted outside.

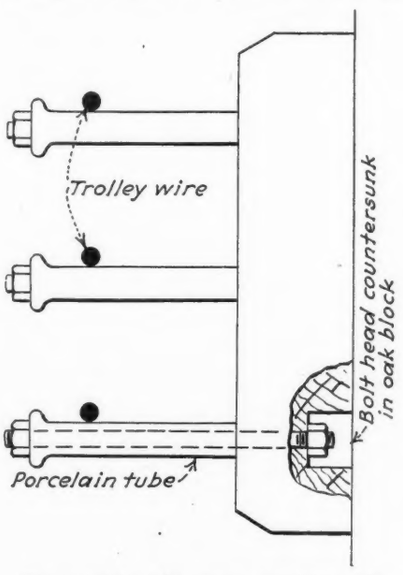
AROUND *the* WORKS

THIS SECTION is especially devoted to short articles describing ideas and practical methods devised to meet particular operating conditions. The items may refer to mechanical details of installation, inspection, testing, wiring, repair, maintenance, replacement, and emergency or unusual installations of equipment tributary to production. Special attention is given to shop or bench tools and short cuts or improved methods of handling work brought into the repair shop. Contributions from our readers are always welcome.

Emergency Use of Porcelain Tubes as Crane Trolley Wire Supports

SOME time ago I was called into a new industrial plant to check up a 10-ton crane. The crane had been wired and the trolleys were in place, but, current had not been turned on. When everything was in readiness I closed all the switches and tried each motion. Everything seemed to be all right; so a run down the building was tried to determine whether the trolley wires were aligned and making contact with all three wheels, as the crane was operated by three-phase, slipring motors.

The crane had moved only about 10 ft. when a loud noise was heard, indicating that something had caught. I stopped at once, but it was too late. Owing to an oversight the trolley wheels would not pass between the porcelain insulators supporting the trolley wires, which were mounted on bolts along the runway. Fortunately, the mounting turned in its fastening and the wheels were not broken or torn loose.



The porcelain tubes were mounted on the bolts provided for the original insulators, which were too large to permit the trolley wheels to pass between them.

It was too late to redesign the trolley assembly, but it was found by measuring the space between the bolts that the wheels would have about an inch clearance between them. Inasmuch as the voltage was only 220 and the bolts were countersunk and mounted on wood blocks, it was decided to use ordinary porcelain tubes 6 in. long and 5/8 in. inside diameter as insulators.

The trolley wheel merely lifts the wire from the tube and then lays it down again. There is no blow to break the tubes and as an emergency measure they have served their purpose well.

Birmingham Ala. GRADY H. EMERSON.

Making Foundation Anchor Bolts with Cutting Torch

CUTTING and welding equipment in the hands of an intelligent operator can solve many emergency problems in the miscellaneous construction and repair work which is necessary around any industrial plant. A good example of this occurred in connection with the installation of a new machine.

When it came time to set the foundation, it was found that anchor bolts had not been provided. In order not to delay the work, a very effective type of expansion bolt was made by cutting a longitudinal slot in a headless bolt by means of an acetylene cutting torch. A steel wedge was inserted in this slot and the bolts were driven down into the holes until they struck the bottom.

Chicago, Ill. G. F. H.

Try This Method of Finding Area of Irregular Sections

WHEN it becomes necessary to determine the area of small, irregular smooth sections of steel in a hurry and the usual methods for standard sections cannot be applied, try the following method, which will prove to be as accurate as triangulation.

Grind the section to be measured with an abrasive until a smooth surface having a definite edge is obtained, and then scrape pencil lead (graphite) on the edge by holding the pencil at an angle to the surface. Be sure to do this very lightly so as to deposit an even amount on the edge only. Blowing on the surface will remove the particles that do not adhere to the edge or surface.

Place a white blotter on the desk or bench, and holding the section about 1/16 in. above it, strike the section a sharp blow with a hammer or other object so that a clear impression is outlined on the blotter.

PREPARING the edge of the object with graphite prior to reproducing a faint outline on a blotter as shown.

All that remains to be done now is to planimeter the outline and there you have the area. The less graphite used, the sharper the outline will be.

Additional "Around the Works" Items Will Be Found on Pages 131, 144, and 148

Comment on Easy Method of Stripping Stators and Armatures

ON page 480 of the September issue of INDUSTRIAL ENGINEER, Mr. Carl A. Wagner recommends burning off the coil insulation when stripping armatures and fields. This method is all right in its place, but must be used with care. Many motors, particularly in the smaller sizes, have fiber punchings supporting the laminations in the field and armature assembly, and if the fiber is burned off, the entire core will be loosened.

Another objection in the case of modern induction motors is the possible loss of alignment. With airgaps reduced to the practical minimum for improvement of power factor, a slight springing of the shaft or other parts may throw the armature off center enough to cause noisy operation and excessive bearing pressures on account of uneven airgaps. The manufacturers are continually striving for mechanical and electrical improvement, and it is mistaken economy for the repair man to impair the workmanship on the motor for a saving in stripping time.

W. B. SHEPPERD.

Engineering Department,
Century Electric Company,
St. Louis, Mo.

INDUSTRIAL ENGINEERING

Plant Engineering in Industry

L. C. MORROW, *Editor*

Chicago, March, 1930

Looks Like the Management Congress Has Done a Real Job

IT was very much worth while—the gathering of management in Chicago early this month at the first National Management Congress and Materials Handling meeting. Interchange of ideas, gathering experience data, making contacts, exposure to the germs of progress—these are the products and by-products of such meetings. The many people in attendance got what they came for.

The exposition of management, materials handling, and plant service equipment was an appropriate adjunct to the technical meetings. It provided the actual contact with things physical that is desirable in keeping such gatherings close to actualities.

Plant engineering and maintenance men took an outstanding part in the program. One session belonged entirely to them, and the questions raised for discussion as well as the three addresses showed that remarkable progress has been made during the past few years in analyzing and developing this important function of industry. They indicated, also the need of a forum such as the gathering this year afforded.

Logically, the congress, materials handling meeting, and exposition should be repeated next year, in order to take advantage of the momentum that has been acquired.

Do Not Mistake a System for an Organization

EVERY plant engineer has the task of directing the many activities of his men so that the functions for which he is responsible may be properly discharged in the most efficient manner. The magnitude of this task is not always apparent, and there is a good chance that the wrong viewpoint will prevail in approaching it.

System, routine, and order are the slogans of the day and have been greatly stressed. Essential as they are to the proper functioning of any organization, proof is not lacking that too much system may defeat its own purpose. Perhaps this condition comes about through failure to realize that there is a vast difference between a system and an organization. The latter is composed of men; the former may be likened to a path that may or may not lead to the desired goal.

No amount of system and routine can make up for incompetence and other inherent deficiencies in an organization. The most that it can do is to co-ordinate activities and help to insure proper direction of effort. To that extent an orderly system is indispensable. When reliance is placed on it to cover up ignorance or indifference, the result is almost certain to be disappointment. If too much system and routine are imposed on any body of workers there is serious danger that working the system will become the main objective, instead of the efficient performance of important functions.

In all of its many phases, plant engineering calls for a high degree of resourcefulness, training, initiative, and the ability to think fast and straight. When motivated by loyalty and enthusiasm for the job, these qualities make a combination that few, if any, problems or emergencies can daunt. With any force of men possessing these characteristics, too much red tape is very likely to be a hindrance rather than a help.

Any executive, regardless of title, who devotes more time to working out systems than to building up a loyal and efficient organization is making a serious mistake that some day may be extremely costly.

The Vacuum Tube Goes to Work in Industry

FOR the past few years vacuum valves, or tubes, have been a familiar piece of equipment in almost every household. They are the foundation of the modern radio receiving set, and in that capacity have become known, and brought entertainment and pleasure, to millions of people. Perhaps the very magnitude of this service and their popularity have prevented wider recognition of the fact that these comparatively simple devices have immense potentialities for service outside the field of communication.

In fact the vacuum valve, in some of its modifications, has put on a uniform or overalls, so to speak, and is performing a host of jobs that are entirely outside its important role of parlor entertainer. For example, in the role of policeman it is operating traffic signals, helping to guard safes and vaults, and assisting in the detection of criminals.

In industry, vacuum valve equipment is sorting, inspecting, counting or weighing cigars, beans, yeast cakes, and other products, and performing other services without error, as it is free from such important influences as fatigue and other human frailties that so often affect judgment and precision of movement.

With this equipment it is equally possible to check the homogeneity of steel rails, measure the

"knock" in different gasolines, detect variations in the acidity or alkalinity of water or other liquids, locate deposits of oil or metals in the earth—or listen to a fruit fly eat its breakfast deep in the heart of a grapefruit!

These are only a few of the actualities; whither the possibilities will lead cannot yet be told. Certain it is that the way has been opened for the development of a new field of science and engineering based on electron phenomena, just as the present field of electrical engineering is based largely on magnetic-induction phenomena.

A new item has been added to the already long list of equipment for which the plant engineer is responsible. It will behoove him to waste no time in becoming thoroughly familiar with the characteristics and possibilities of this device.

They Wanted a Better Washroom

DETECTIVES get into some peculiar jobs. A case in point involved labor turnover in a machine shop. Upon being called upon to find out why the turnover the agency placed one of its employees, a machinist, on the job. It wasn't long until he found that most of the men leaving went to one other plant and that they went because that plant had a better washroom.

The day of the roller towel is past. So are the days of the common basin, washing in standing water, lack of hot water, and similar inconveniences and insanitary conditions.

Some plants see far ahead in such matters; others wait until they are hit in the pocketbook. Granted that the whole family of an employee may use one towel, one drinking glass, and one wash bowl at home, that's no reason why he should be forced to behave the same way with the plant family—after all there is a lot of difference. By and large, it's a good thing when employees quit jobs and take on others just to get better sanitary conditions. But it's a rather sad commentary on the plant that loses them when a detective is required to find the trouble.

Beware the Cheap Paint Job

THERE are no bargains in industrial painting jobs. Good jobs, good paint. Good paint, good price.

If walls are quite dirty, one coat of good paint will not cover properly. Paint can be compounded to cover, but the results are not lasting. After a short time the paint will become chalky, or flaky, and will be knocked off easily. Or the oil that is the vehicle may not be of the proper type to prevent yellowness.

Some plants do their own painting, others get contractors to do it. In either case the price that is extraordinarily low, for paint or for paint and labor, deserves some skeptical consideration. Probably the safest procedure is to ask a reputable manufacturer of paints to provide specifications to which the plant forces or the contractor must adhere.

Manufacturers Should Be Told of Equipment Failures

MAINTENANCE departments can be of great assistance to the general economic welfare if they will report back to manufacturers the causes for failure of equipment.

Not a new idea, but one that crops up occasionally and finds strong devotees. Brandt, of Westinghouse, endorsed the idea at the maintenance session of the management congress. He placed himself on record as wanting all the failure information he can get on the equipment that his company builds.

Equipment isn't sold today merely on the basis of getting the money. The manufacturer wants it to really do the job for which designed. There is more careful engineering put into the design than ever before. Tests in the manufacturer's own factory are one thing, but service requirements are another. It's the maintenance department that is in position to analyze the behavior of equipment on the job. For its own purposes this department keeps performance records which include data on failures. Reporting back to the manufacturer is a self-protecting measure that can be taken without much additional effort.

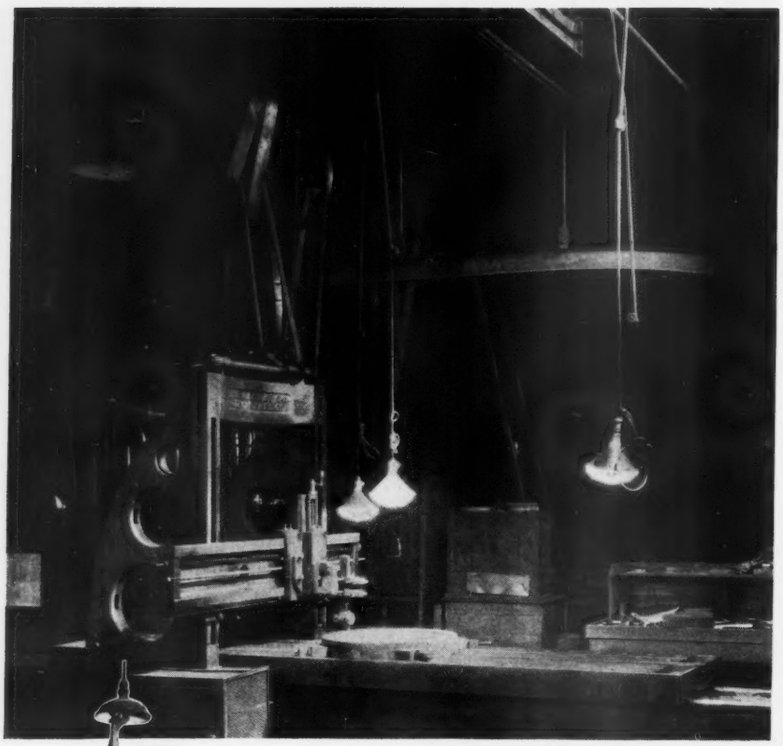
Rehabilitate During Slack Times to Secure Low Cost

PLANT rehabilitation during slack production seems such an obviously desirable program that no exhorting should be necessary. But it was brought out at the maintenance session of the recent management congress that many plants don't do it in spite of believing in it. Orders drop off, production has to be cut, and off go the heads of many of the maintenance crew.

It just shouldn't be done. In 1921 we knew that the depression had to give way to prosperity. Some of the wiser organizations got all set for real production by getting their plants in shape—but many didn't. In the present lesser depression we hear the same story—"It's a good thing, but we've got to cut down expenses."

Well, the plant engineers know that in the long run the rehabilitation and maintenance work can be done at less cost when some of the equipment is idle. Some reduction in force? Yes, they admit that's desirable, necessary, and workable. But drastic reductions, no.

LET THERE BE *ENOUGH* LIGHT



Very effective pictorially, but what happens when an overhead belt breaks, or a bearing burns out? The gloom overhead also discourages thorough inspection and oiling.

One of the cheapest forms of good lighting insurance—periodic inspection, maintenance, and replacement. The mobile ladder and cleaning kit make the job easier.

Lamps of the correct intensity, with reflectors at the proper height and spacing, mean more output, less spoilage, and fewer accidents. *(Right)* Rapid and accurate work is impossible with this combination of glare and gloom. The constant eye adjustment necessary in such a room is a serious menace to the workers' health.

This Month's Cover

SHOWN on the front cover in this issue is the plant of the Geo. E. Keith Company of Campello, Brockton, Mass. It is in this plant that the Walk-Over Shoes are made.

The scope of the plant engineering function is indicated by the following statistics: There are 2,500 installed boiler horsepower; 1,500 motors ranging in size from 1/20 to 100 horsepower; 1,000 ft. of tunnels connecting all buildings and housing heat, light, and power feeders; one mile of railroad track sidings; 200 telephones; 4,000 connected horsepower in motors; 9,500 electric lamps; 21 elevators; 1,000 ft. of conveyors; 7,500 ft. of line shafting. There is a fully equipped club house, with park, controlled and governed by the employees.

The Mechanical Department of this plant is under the direction of a mechanical engineer in charge of power, construction, and maintenance. At the main plant (shown on the cover) this department is divided into five sub-departments, Electrical, Heating, Steamfitting, Carpenter, Yardmen and Power House. The function of power and maintenance in each of the five factories located in other cities is under the charge of an individual.

Set-up and operation of the Power and Maintenance Department in all of the factories is based on the Plant Engineers' code published in *Industrial Engineering*, January and February, 1928.

Some of the buildings in the group illustrated are obviously old. Such a condition is almost certain to exist in an industrial community as old as New England. On the other hand, some of the buildings shown are thoroughly modern. As the demands of industry increase, the obsolete buildings are being replaced by buildings that are ultra-modern.

Efficient Inspection Is Worth Many Times Its Cost

REGULAR inspection of plant equipment, motors especially, constitutes the best known means of circumventing incipient troubles that are caused chiefly by the entrance of foreign objects such as chips, cuttings, abrasive dusts, etc., into the moving parts.

Compressed air is used to some extent in removing such particles but its use is being discouraged because it has the tendency to drive chips, cuttings etc., into the windings where they become firmly lodged.

If motors are to be subjected to acid fumes, the winding should be treated to withstand such service, or totally-inclosed covers should be supplied. Care should be used in applying these covers, as totally-inclosing covers shut off all ventilation and decrease the full-load rating at the guaranteed temperature.

In addition to regular inspection by trouble shooters, some types of equipment may require special inspection. Cranes, elevators, and conveyors, by which human life may be endangered through improper functioning, should be inspected periodically and tested thoroughly for operation. This should be done by a person who is competent and does not believe in taking chances. Inspection standards should be very rigid and if, in the opinion of the inspector, the equipment is not entirely safe, it should be taken out of service immediately. After repairs have been made, the inspector should make another thorough test before the equipment is put back into service.

Although inspectors and trouble shooters are employed to care for the shop equipment, the machine operator should not be relieved of all responsibility in the care of his machine. He should be instructed to report at once any irregularity in the operation of the electrical apparatus. Damage may be done to the work in the machine, or to the machine itself if the operation is faulty. Even if no immediate damage is likely to result, it is far more economical to make a few minor repairs or adjustments than to allow the equipment to reach such a condition that expensive repairs will be necessary.

Wood That Won't Burn

MODERN chemistry is doing wonderful things. It is doing things of which they used to say: "It can't be done." We now have a report by U. S. Tree Commissioner F. B. Lyon from Oslo, Norway, that an engineer in Norway has succeeded in impregnating wood with a substance that makes the wood fireproof. The process is also applicable to paper. Frame houses are thereby made entirely fireproof. In Oslo a building was treated with this solution and a number of attempts were made to set it afire. But it would not burn. According to reports, manufacturers will soon be turning out this product on a large scale.

W. F. SCHAPHORST.

Lamme Medal Awarded to R. E. Hellmund

"FOR his contributions to the design and development of rotatting electrical machinery," R. E. Hellmund, E. Pittsburgh, Pa., has been awarded the Lamme Medal of the American Institute of Electrical Engineers. It is expected that the presentation will be made at the summer convention of the institute which will be held June 23-27, 1930, in Toronto, Canada.

As a result of a bequest of the late Benjamin G. Lamme, chief engineer of the Westinghouse Electric & Manufacturing Company, to provide for the award by the institute of a gold metal annually to a member of the American Institute of Electrical Engineers, "who has shown meritorious achievement in the development of electrical apparatus or machinery," the Lamme Medal was founded.

Rudolph Emil Hellmund, chief electrical engineer of the Westinghouse Electric & Manufacturing Company, was born in Gotha, Germany, Feb. 2, 1879, and educated at Ilmenau Technical College, and the University of Charlottenburg.

Prior to his post graduate studies at the latter school he was engaged in design and laboratory work in Cologne and Stuttgart.

Coming to the United States he was successively connected with the Krantz Company, Brooklyn, N. Y., William Stanley, Great Barrington, Mass., Western Electric Company, Hawthorne, Ill., and in 1907 joined the Westinghouse Company as a designer of induction motors. In 1912 he was placed in charge of the design of all d.c. and a.c. railway machines.

Mr. Hellmund is the author of many papers covering such subjects as rotating fields and leakage fluxes in a.c. machines, single-phase commutator motors, regenerative control, electric traction, engineering education, and so on.

SYNCHRONOUS

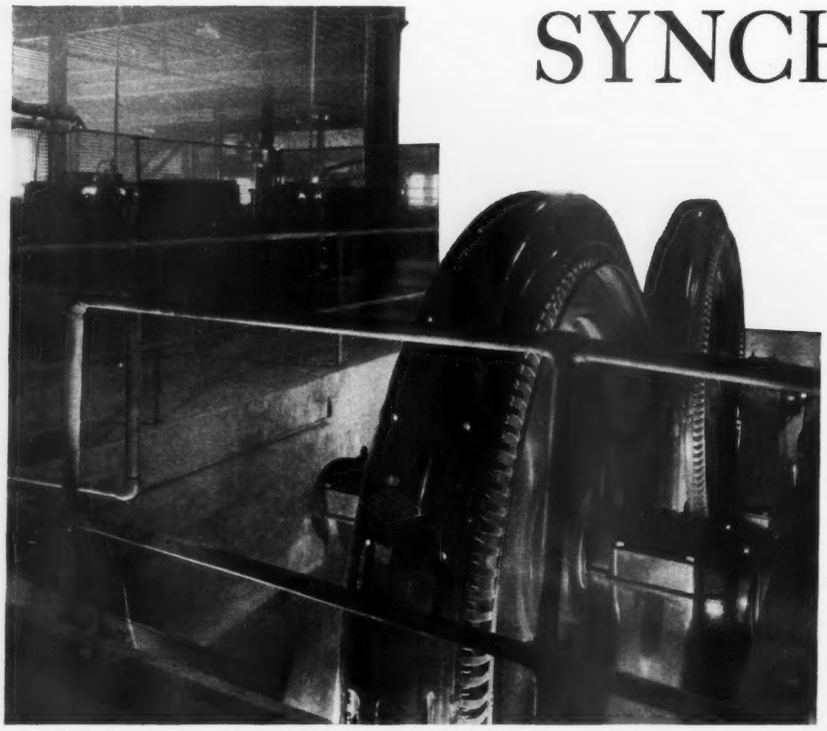


Fig. 1—Synchronous motors rated at 250 hp. driving three 18x30-in. refining mills.

An application where a lower initial investment was possible because of the simplified operation without sacrificing safety, and where improvement in power factor was an incidental gain.

By E. G. PETERSON

Electrical Engineer
Cutler-Hammer, Inc., Milwaukee, Wis.

THERE may be many misconceptions about power factor, but plant engineers have not been slow in utilizing the savings attributed to its improvement from the application of synchronous motors to heavy drives toward the reduction of production costs. Notwithstanding their widespread use throughout industry, synchronous motors were until a decade ago, the least known, especially as to characteristics, of all motors. As a result, their application was confined chiefly to generator drives of motor-generator sets.

Little or no consideration was given toward their application on mill line drives, where the wound-rotor motor was preeminently established, until their characteristics had proved that they were suitable.

As evidence of their suitability on heavy drives is the installation in the plant of the Akron Rubber Reclaiming Company, Akron, Ohio, shown in Fig. 1, and which consists of 6 motors, each rated 250 hp. at 90 r.p.m., connected to rubber mill line drives.

At one time or other in this industry fully 90 per cent of the mills were driven by wound-rotor induction motors through the medium of d.c. magnetic clutch brakes. This type of drive was in many ways ideal. The slip-ring motor provided ample starting torque without severe line disturbance and it had a good pull-out torque for sudden peak loads.

The magnetic clutch brake was primarily a safety device used to uncouple the high-speed, high-inertia motor rotor from the low-speed, low-inertia mill line. A quick stop of the mill rolls was obtained by incorporating a large band brake in the driven member of the clutch. This brake was solenoid released as long as the clutch was energized and set by a weight as soon as the clutch was disengaged by tripping the safety switch. A simple manual starter for the motor sufficed.

Such an installation is illustrated in Fig. 2. The motor, magnetic clutch brake, and the single-reduction gear unit were generally installed in a pit. The main drive shaft for two, three, or four mills in a line was thus kept below the floor level, out of the way. Each mill was driven by a pinion on this line shaft meshing with a large spur gear driving one of the rolls of the mill. Each mill consisted of two horizontal rolls in a suitable housing. The other roll was geared to run at a different speed so as to produce a kneading action when the material passed through them. In Fig. 3 a typical layout is indicated.

Due to the inherent poor power factor of a slip-ring induction motor experiments were made to replace the induction motors with synchronous motors. The first installation simply substituted a synchronous motor for the induction motor. The motor was started idle, and the load picked up by energizing the clutch.

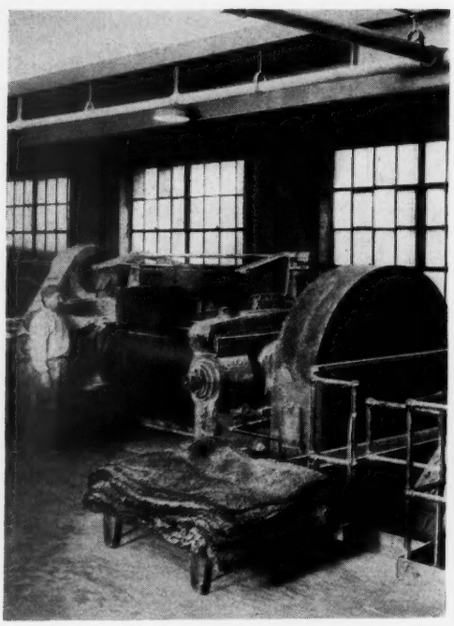


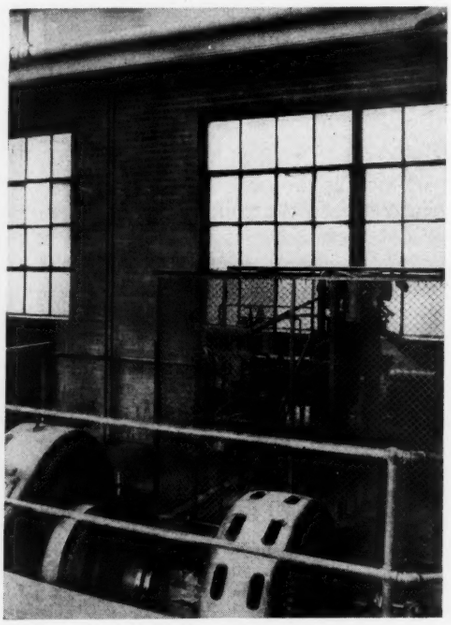
Fig. 2—An installation typifying the application of the wound-rotor motor. The motor, magnetic

After a few such installations had been made, tests demonstrated that the synchronous motor provided ample starting torque with empty mills. With the mills full, it was found that the rolls could be reversed and the material backed out sufficiently to permit the motor to start before the rubber entered the bite of the rolls. Since a magnetic

MOTORS *for* HEAVY DRIVES

clutch was not necessary for starting purposes, the question naturally arose as to whether or not is was necessary for stopping purposes.

Dynamic braking was not obtainable on a slip-ring motor, but it could be obtained on a synchronous motor by disconnecting the a.c. supply and connecting the motor stator terminals to a resistor of proper value. With the d.c. rotor energized, dynamic stop was obtained. Thus the motor became an a.c. generator, d.c. excited, pumping current into a resistor, with the inertia of the mill and motor rotor supplying the power. Tests indicated that a satisfactory quick stop could be obtained in this manner.



clutch brake, and the single-reduction gear unit were generally installed in a pit.

In this way two benefits were obtained at once. The synchronous motor replaced both the induction motor and magnetic clutch. The initial cost was therefore reduced, and the running expenses reduced owing to the better power factor obtained. Figs. 4 and 5 show synchronous motor drives with and without magnetic clutches.

Just prior to the general adoption of synchronous motors, one large installation was made using wound-rotor motors without magnetic clutches. The quick stop was obtained by reversing or plugging the motor and providing a friction switch which disconnected the reverse contactors at the instant the motor speed reached zero, owing to the braking action of the reverse torque. This same principle has been applied to synchronous motors. These motors in the Akron plant are started by a full-voltage, automatic starter and stopped by plugging when the safety switch is tripped. Instead of disconnecting the stator winding and short circuiting it through a three-phase resistor, two phases of the stator winding are reversed and the motor is brought to rest by the reverse torque thus set up. A hydraulic relay driven by the mill disconnects the motor when it has slowed down to dead rest. Four tests were made with the mills empty and the following measurements were taken of travel on the small roll before stopping: 12, 15, 14, and 12 in. With rubber in the mills this travel would be reduced to less than 5 in. The current inrush on starting was 192 amp. and on plugging 252 amperes.

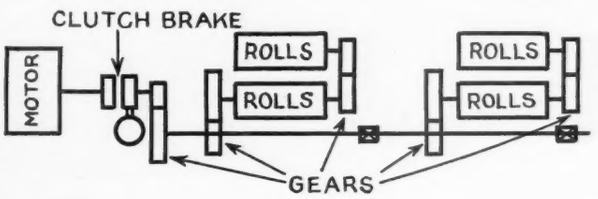


Fig. 3—A typical layout of rubber mills in line.

Restricting the travel of rolls at the instant of stopping is no more

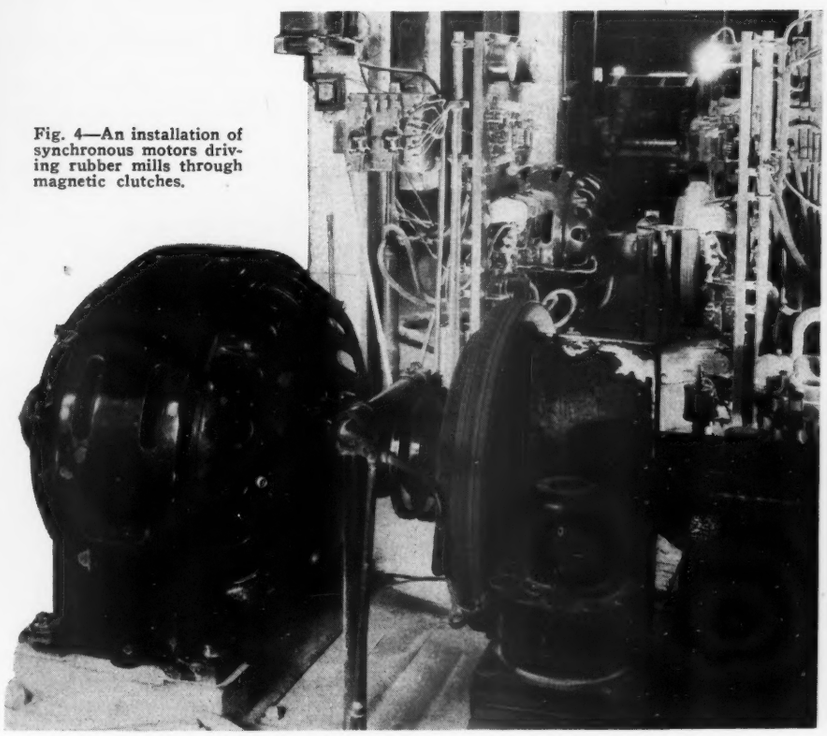


Fig. 4—An installation of synchronous motors driving rubber mills through magnetic clutches.

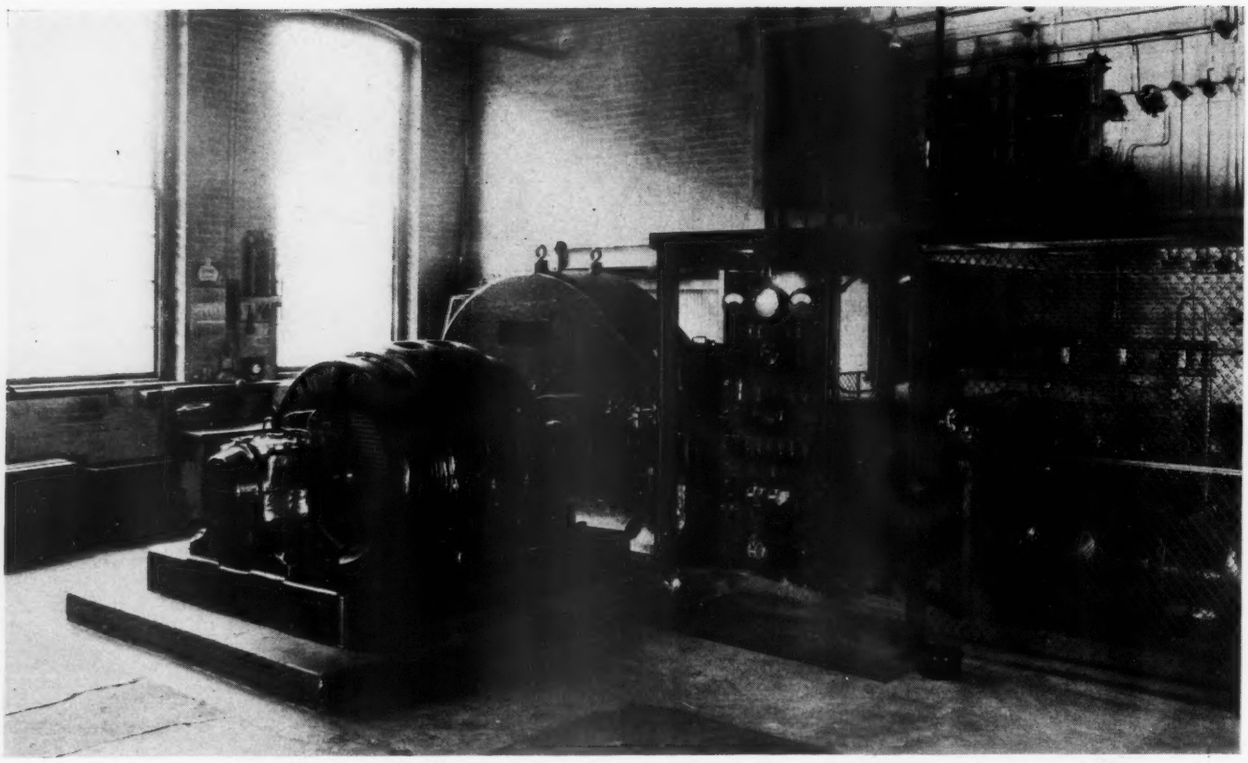


Fig. 5—Synchronous motor on mill line drive without the use of a magnetic clutch. The dynamic-braking, automatic-control equipment is featured in the foreground.

than a safety feature because the mill hand who works on a rubber mill is conceded to have a very hazardous occupation. The rolls rotate toward each other when looked at from above. This movement gives the rolls a bite, which together with the stickiness of the material forms a constant threat of injury. A slip or a moment's carelessness in adding material to be mixed and the operator's arm is being drawn between the rolls and crushed.

A safety switch and cradle, which can be seen in Fig. 2 is installed above each pair of rolls. As soon as the mill operator feels himself being drawn into the rolls he can throw his free arm or his body against this overhead cradle mechanism and stop the rolls in a few inches of travel.

Starting the mill again with material between the rolls after an emergency stop requires a motor with a large starting torque. Since the wound-rotor motor provided these characteristics and since the magnetic clutch brake provided adequate safety provisions, this type of drive accounts for its use for many years.

Determining Safe Loads for Ropes, Cables, and Chains

MANY times a person discovers that he has purchased or used a rope, cable, or chain that is much too light for the job at hand. The breaking of such equipment results in loss of hard-earned cash; at times human life may be endangered. Therefore, it is desirable to have some easy method by which the strength of a given rope, cable or chain may be determined beforehand.

In the case of hemp rope, the safe working strength may be considered as equal to the circumference of the rope squared times 100. To find the circumference we can measure it with a tape, or multiply its diameter by 3 1/7.

Suppose we wish to pull or lift an object requiring a pull of 1,500 lb. and want to select a rope that will stand the stress safely. The circumference of the rope may be found by changing our formula around slightly, as follows:

$$1{,}500 = 100\,C^2, \text{ or } C = \sqrt{1{,}500} \div 100,$$

which equals $\sqrt{15}$, or 3.875 in.

Now, to find the diameter of the rope required, divide 3.875 by 3.1416, which gives 1.23 in., or a rope having a diameter of 1¼ in. would be used.

Again, assume that a rope 1 in. in diameter is available and it is desired to move an object requiring a pull of 1,000 lb. Will the rope be strong enough? Applying the formula: Working load $= 100\,(1 \times 3.1416)^2 = 987$ lb., which is so close to the requirement of 1,000 lb. that the rope may be used safely.

The formula for the strength of wire cables is very similar and worked in the same manner. The formula is: Safe working load $= 1{,}000\,C^2$.

The formula for the strength of open-link chains such as the ordinary log chain is slightly different from that for ropes, but is worked in exactly the same manner. The formula is: Safe working load $= 12{,}000\,d^2$. That is, the diameter of the link squared times 12,000 gives the working load. For example, consider an open-link chain having ¼-in. diameter links (meaning the diameter of the wire from which the chain is made). The safe working load of this chain is $12{,}000 \times 0.25^2 = 750$ pounds.

Waterloo, Ia. H. C. CHARLES.

AROUND *the* WORKS

Method of Providing Distant Control of Large Switch

THE diagram shows the arrangement of a system in actual use by means of which a 110-kv., air-break switch is operated from a point about 3 miles away.

The scheme was worked out when an industrial plant which originally generated its own energy, and also handled a certain portion of a local distribution system, found it necessary to provide for additional capacity. A survey of the territory showed that the quickest solution was to provide a connection to a 110-kv. circuit located about 3 miles from the plant. A bank of three 1,000-kva. transformers was installed at the point where the 110-kv. circuit was to be tapped, to step the voltage at *C* down to 13.2 kv., as this was the highest voltage that it was desirable to carry to the plant.

The 110-kv. side of the bank is controlled through a motor-operated air-break switch, with the control point located at panel *P* in the plant. For this service use was made of a local single-phase, 2,300-volt line which was close to the tap point, and a third conductor, *O*, was put up between the two points. Four control transformers, T^2, T^3, T^4 *and* T^5 were installed to connect control switches *1* and *2* on panel *P* with the control relay *B* at the tap point. Transformer T^1 was installed to operate the air-break switch motor. All of the transformers referred to are rated at 1 kva., 2200/110 volts.

Relays *B* and *R* are similar to a well-known standard control relay; transformer *V* is a standard potential transformer; breaker *D* is electrically operated; *F* and *G* are red and green indicating lamps to show the condition of the 13.2 kv. circuit; breaker *D* is arranged with an auxiliary switch, *Z*, which is open when the breaker is closed so that switch *A* cannot be closed unless breaker *D* is first opened. This provision was necessary in order to force all synchronizing to be done with breaker *D*.

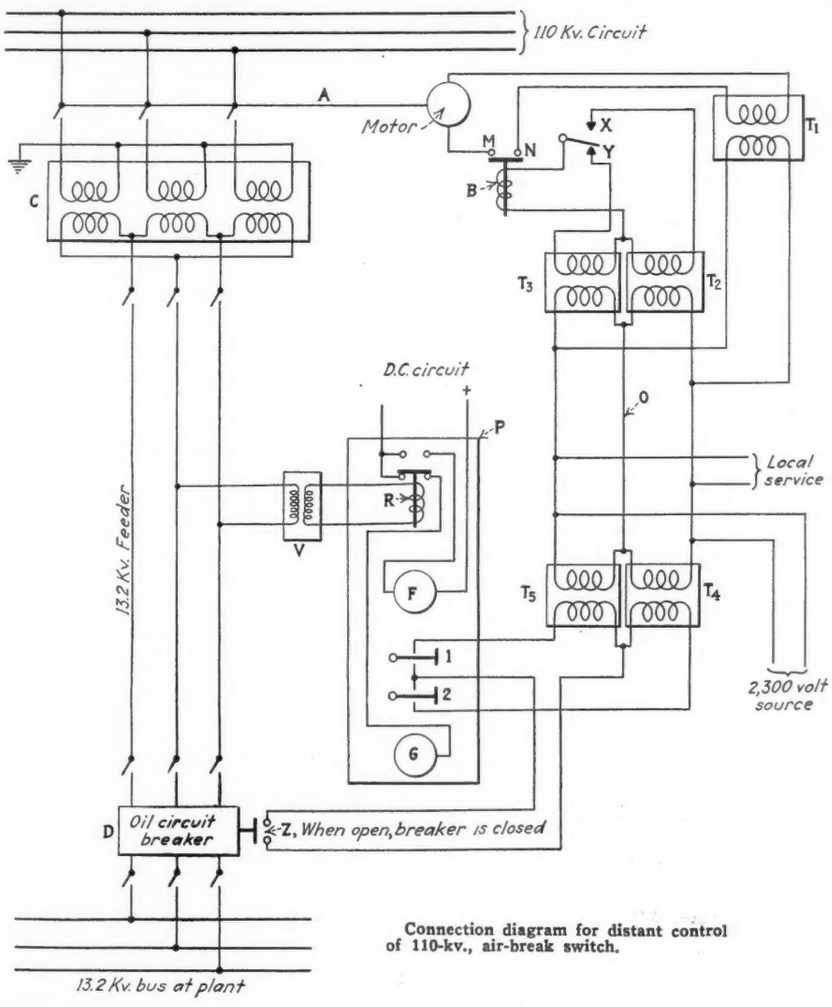
The method of operation is as follows: Relay *B* normally receives one-half voltage from transformers T^2 or T^3, which are connected in series across 2,300 volts; this voltage is not enough to operate it and raise the plunger to close the motor circuit through contacts *M* and *N*. One side of relay *B* receives its energy from either T^2 or T^3 through contacts *X* and *Y* which are operated mechanically from the shaft of the switch motor when it has reached the limit of its cycle.

Closing either control switch *1* or *2* short-circuits the low-voltage winding of either T^3 or T^4, which allows practically full voltage to be impressed on T^2 or T^3 respectively, and permits an increase of current in relay *B*, enabling it to lift its plunger and close contacts *M* and *N*. This action in turn starts the motor, allowing it to rotate until it is stopped by the opening of *X* or *Y*. The completion of the cycle is indicated by the lamps *F* or *G*.

Holding either control switch closed after the motor has completed its cycle of operation causes no disturbance, as the opening of the local circuit at *X* or *Y* stops all current flow.

All of the equipment used is standard with a number of manufacturers and requires a minimum number of conductors between the two stations. The size of the control conductors needs to be only sufficiently large to give the requisite mechanical strength, and inasmuch as the control current, which is less than 1 amp. on the 110-volt side, is practically negligible, it could be carried a much longer distance than was necessary here. This method of controlling the switch also makes it unnecessary to use a battery at the tap point.

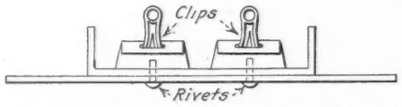
C. O. VON DANNENBERG.
New York, N. Y.



Connection diagram for distant control of 110-kv., air-break switch.

Using Paper Clips to Hold Rivets in Place

WHEN two or more rivets are to be used to hold two pieces of metal together it is difficult to do the job properly unless all of the rivets are held in place at the same time. If one rivet is driven home before any of the others are put in place it very often happens that the pieces of metal will move, causing the holes to be out of line.



Misalignment of holes can be avoided by putting all of the rivets in place and holding them with paper clips.

This difficulty can be eliminated by placing all the rivets in at once and holding them with spring paper clips, as shown in the illustration. Take the paper clip off each rivet after the latter has been placed on the riveting bar or anvil. The use of paper clips will make it possible to keep all holes in line and do the job better and quicker.

Denver, Colo. R. M. THOMAS.

Maintenance and the premium

By J. MacNIESH

MODERN industrial success is measured in terms of production. Quantity in large volume indicates a lower cost per unit, a larger market and reckoned by older standards, a smaller overhead.

Competition, rather than limiting the field for expansion, helps develop it. It emphasizes the factor of quality, promotes that brand of high-pressure salesmanship that has done so much to make the trade name of the product a household word and, paradoxical though it seems, increases production.

Production, in a word, is the mainspring of modern business. It is the vital organ alone responsible for the present era of prosperity in this country. In its interests, its promotion and safeguarding, highly specialized energies are constantly working out in the laboratory or the conference room, theory being balanced against experience, new methods and conditions for the achieving of still greater efficiency.

In a large manufacturing plant in New Jersey there was experienced not long ago a problem which, although identified while still in embryo stage, was none the less a proposition that demanded skilled deliberation and a speedy solution. Production was beginning to get affected. Protracted delay in the returning of production machinery to service had reached the stage where it was no longer to be disassociated with what seemed an excessive amount of overtime in the maintenance department. The overtime, apart from its relation to production, was in itself no mean liability, for it meant an exaggerated overhead. What was to be done?

The circumstances being weighed and duly appreciated, a course of action was finally decided upon. This took the form, first, of a time-labor study on all maintenance jobs where the nature of the work permitted a faithful valuation. Work was measured in time-labor units and on this basis of computation—the unit equalling work accomplished in one minute—it was found that the output of the maintenance department averaged sixty time-labor units per hour. The term "averaged," it is to be explained, is used here to indicate the variation in individual performance on any given job. Degrees of skill or familiarity in the operators altered with the changing nature of the work. Hence the fluctuating scale of values from which the average was struck.

It was at this figure, sixty time-labor units per hour, that the excess of overtime was essential to cope with the volume of demand. The maintenance crew was not undermanned. The whole trouble, it seemed, centered in the overtime. Long hours of labor do not mean an output in proportion to the production of the first hour or two. The marathon runner has not the speed of the hundred-yard dash man. He has to conserve his energies to last out the longer distance. Similarly with the man who is aware that he has to outlast the ordinary hours of the working day and a few more besides. He does not stretch himself; his week's endeavor will show in terms of time rather than work.

The problem then resolved itself into providing an incentive to increase the hourly turnover and so shorten the hours of overtime. And it was for this purpose that a system of premium was introduced.

The premium was based on what could be saved, by cutting down overtime, on the department's average payroll. Whatever saved came back, in whole, to the personnel.

The new order of things was explained to the maintenance crew. They were educated to appreciate that the high wages, previously won by long hours, could now be gained by eliminating the necessity for overtime.

The system, once fully understood, caused an immediate improvement in the condition that had caused so much trouble. There was an all round speeding up of work. Overtime lost its old time attraction. Its necessity, from a lucrative point of view, as the personnel saw it, was entirely obviated. Rewards came from industry. The premium that had induced them to forsake overtime was compensating them with an equivalent in cash and also giving them the benefit of a leisure time for rest, study or recreation.

From the managerial angle the experiment was a decided success. Analysis, some time later, taking the form of a second time-labor study, disclosed the interesting fact that output for the maintenance department had increased to approximately eighty time-labor units per hour. The premium paid per week amounted sometimes to more than thirty per cent. Figures, in this case, illustrate the real service that can be rendered by a premium system to the cause of production.

Washington Award for 1930 Goes to M. E. Cooley

PRESENTATION of the Washington Award for 1930 was made Feb. 24 to Mortimer Elwyn Cooley, D. Eng., "for vision and constructive leadership in the education of the engineer."

This award is one of the three honors in which all four of the major engineering societies participate. It was founded by John Watson Alvord, "for pre-eminent service in advancing human progress," and administered by the Western Society of Engineers on recommendation of a commission representing the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, and Western Society of Engineers. President Hoover heads the list of eight engineers to whom the award has been given.

Mortimer Elwyn Cooley occupies the chair of mechanical engineering at the University of Michigan. He was a pioneer in the establishment of engineering laboratories to provide students with a practical knowledge of materials and processes in engineering. His vision and constructive leadership have done much to shape the course of engineering education in America.

• QUESTIONS •

Asked and Answered by READERS

•

Preventing Escape of Valuable Material from Dust Collectors

We have a problem in the manufacture of mixed feeds that is very troublesome. Some of our product is caught in dust collectors as it comes from the pulverizers or hammer mill, but too large a percentage of it is lost through the ventilators for these collectors. A stocking placed on the ventilator will filter out the fine material for a short time, but as it is exposed to the weather it gradually becomes clogged with dust, particularly on damp or rainy days, and loses its effectiveness. The dust collectors are placed well above the pulverizers, and the ventilators on the dust collectors are about 40 ft. above the pulverizers. Can anyone tell me how to overcome this trouble?

Cayuga, N. Y. J. M. H.

Preventing Radio Interference From Pole Changer

Considerable interference with radio reception has been traced to an old Kellogg pole changer that is used with our plant telephone system. If any other readers have experienced this trouble, I wish they would tell me the cause and remedy for it.

Utica, N. Y. G. L. B.

Top-to-Top Connection Causes Heating of Motor

Using the connection shown by the diagram on page 127, Fig. 136, in the Induction Motor Connection Book, by Dudley, on a 36-slot form 8-pole machine and employing 1 and 3 jumpers instead of 1 and 6, excessive humming and heating were experienced. What is the reason the top-to-top connection did not work properly?

New Orleans, La. E. J. R.

Combining Advantages of Group and Individual Drives

We are rebuilding a large part of our plant, and a difference of opinion has come up regarding power drives for our machines. They are well suited to group driving, which has been used heretofore, but the "forest-of-belts" appearance is objectionable. Under our conditions I do not favor individual drive throughout, and I am wondering if we could obtain some of the advantages of both types of drive by some such scheme as driving the machines on one floor from a lineshaft on the ceiling of the floor below, or by mounting our lineshafts behind the machines, on the same floor.

If any readers have used either of these methods, or have had experience with other arrangements, I wish they would give me the details and let me know what the results have been.

Cleveland, Ohio. P. M. J.

Ground Detector for Three-Phase System

A few years ago I saw a method of using a bank of lamps to test for, or locate, grounds on three-phase systems, but have forgotten the details. It is my recollection that this scheme was adaptable for different voltages by making suitable connections on the lampbank. If someone can help us out by outlining the best scheme for this purpose, it will be greatly appreciated.

El Paso, Texas. G. W. U.

Avoiding Sagging of Belt on Vertical Drives

We are well aware of the fact that vertical belt drives are often troublesome, but the conditions encountered in some rearrangements that are being made will necessitate the use of several drives that will be approximately vertical. We are using leather belts, and the driving motors range from 5- to 20-hp. rating. Will some readers tell me what is the smallest angle from the vertical that will overcome the sagging of the belt away from the bottom pulley? If we can obtain this angle we may be able to avoid, or lessen, any trouble.

Youngstown, Ohio. L. A. M.

Rewinding Transformer for Use in Thawing Pipes

Several 440/220/110-volt lighting transformers of 5-, 7½-, 10-, 15-, and 20-kva. rating are available in our plant. I should like to rewind one of them to give 200 or 300 amp. for thawing frozen pipes and also for small jobs of welding and cutting. Will readers tell me whether it is feasible to rewind ordinary transformers for such service? If so, (1) what voltage should the secondary deliver? (2) Which of the above ratings would be most desirable for a transformer that is to be rewound for this purpose? (3) Please show how to calculate the secondary winding.

Bellingham, Wash. E. M. D.

Changing 30-Cycle Motor for 60-Cycle Operation

We have a 30-cycle, three-phase, 440-volt, 1,750-r.p.m., 1-hp. motor that was never used. Recently need arose for a 60-cycle motor of 1-hp. rating and I decided to change the 30-cycle motor for this purpose, keeping the speed the same. There are 48 slots in the stator and as it was connected for two poles, I regrouped the winding for four poles and changed the single-circuit star connection into a two-circuit star. The motor ran satisfactorily, but became warmer than I think it should. Was the change I made correct? If not, how should this 30-cycle motor be changed for 60-cycle operation, keeping the same speed?

New York, N. Y. J. S.

Paint and Putty for Damp Location

In the department where we shrink shirt material an excessive amount of moisture is present in the air, and causes the walls and windows to drip water. This condition, in turn, softens the putty and causes it to crumble and fall off the steel window frames. I should like to know whether there is any special kind of putty that would give better service, or something that could be mixed with the putty we are now using to make it more resistant. I should also like to know what is the best kind of white paint to use on the steel girders in the same department. The paint we now use does not last more than three or four months, and then the ironwork starts to rust again. Is there any treatment we can give the ironwork before repainting, that will help us to obtain better results?

Hazleton, Pa. E. B. W.

ANSWERS *to* QUESTIONS

Measuring Belt Tension

In articles on the use of belting for power transmission, the statement is frequently made that the tension on the belt should be so many pounds per inch of width. No doubt this is an important point, but I should like to know how I can measure the tension of leather, rubber or fabric belts while they are on the pulleys. Is there any apparatus or reasonably simple method of measuring belt tension, that can be used out in the shop?
Detroit, Mich. W. E. F.

REFERRING to the reply to W. E. F.'s question by Roy C. Moore, on page 647 of the December, 1929 issue of INDUSTRIAL ENGINEERING, the statement is made, "We know of but one practical way. This is by means of spring scales fastened between one of the clamps on one end of the rods, the clamps and rods referred to being the set used to install the belt or to shorten it."

The objection to that method is that it requires unlacing the belt which, of course, is rather expensive.

A year or so ago I developed some rules for computing the tension in a horizontal belt that is already in place on the pulleys. The tension can be computed without difficulty, and without the necessity of using expensive or complicated apparatus. For mineral-tanned leather belting the rules are as follows:

Multiply the width of the belt in inches by its thickness in inches; then multiply by 0.43 and call the answer *P*. Now, multiply *P* by the sag of the belt in feet and call the answer *A*.

Next, multiply *P* by the distance between pulleys, in feet; multiply that again by the distance between pulleys, in feet; multiply by 0.125 and divide by the sag of the belt, in feet. Call the answer *B*.

Add *A* and *B* and the result is the total tension in the belt, in pounds.

No matter what the sag is, so long as it is measurable at all, the tension can be calculated by the above rule. It may sound rather cumbersome, but it certainly is much easier than taking the belt apart, measuring the tension, and putting it together again.

For example, let us take a case where the distance between pulleys is 20 ft.; the sag is 6 in. or 0.5 ft.; the belt is 6 in. wide and ¼ in. thick. What is the total tension?

Applying the above method we get:

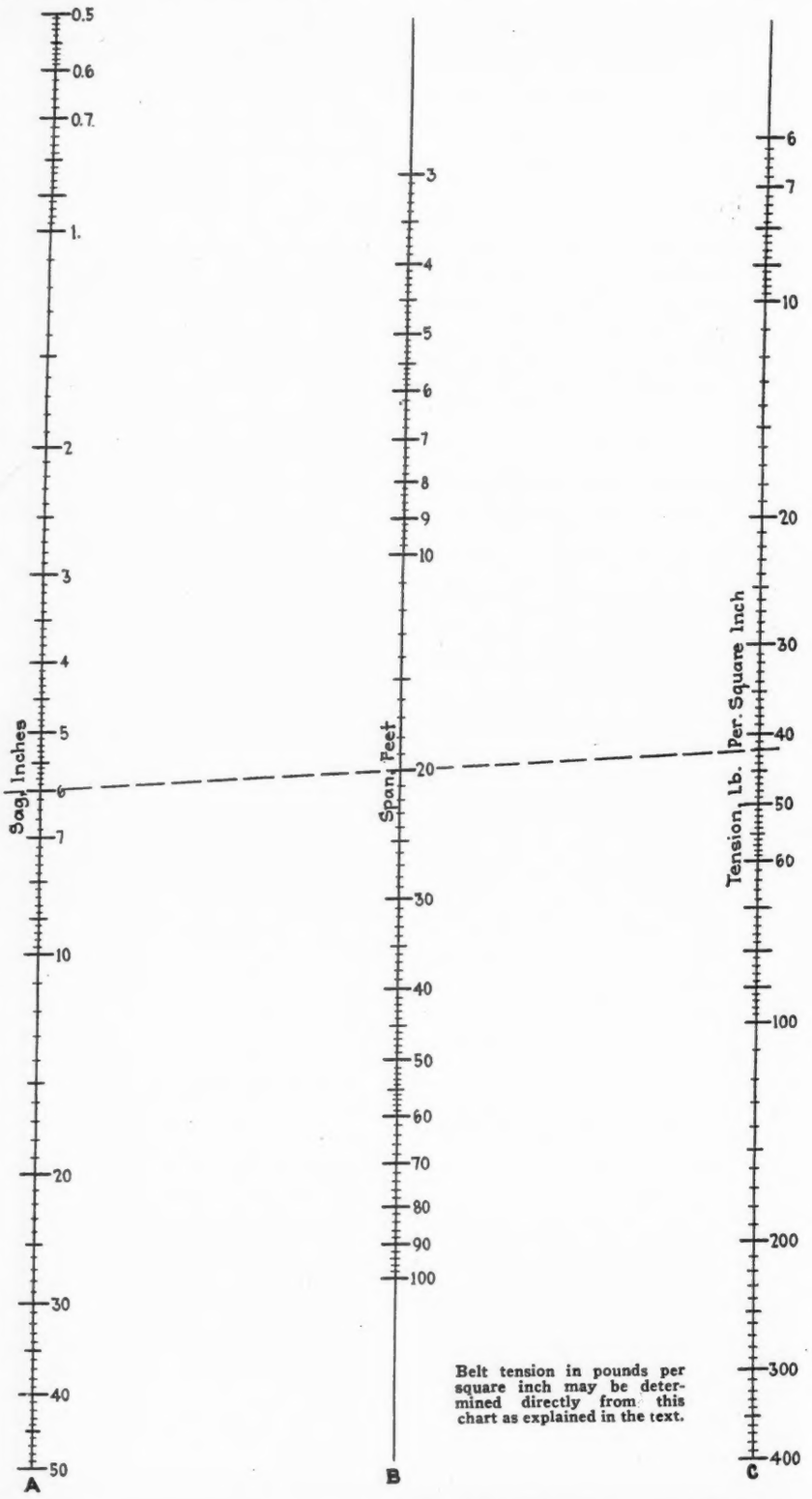
$P=6\times\frac{1}{4}\times0.43=0.645$
$A=0.645\times0.5=0.322$
$B=(0.645\times20\times20\times0.125)\div0.5=64.5$
$0.322+64.5=64.82$ lb. total tension

To make this rule applicable to any type of belt it is merely necessary to substitute other figures for the factor 0.43 used above, which is obtained by multiplying the weight per cubic inch of the given belt by 1.5. Following are the weights per cubic inch of commonly used belting:

Oak tanned—0.035 lb. per cu. in.
Cotton and Canvas—0.026 to 0.05 lb. per cu. in.
Rubber—0.045 lb. per cu. in.
Hair—0.035 lb. per cu. in.

To simplify the matter still farther I have prepared a chart which gives the tension in pounds per square inch directly. Thus, the dotted line drawn across this chart shows that if the sag is 6 in. and the span 20 ft., the tension is 42 lb. per sq. in., which checks with the problem above, the cross-sectional area being 1.5 square inches.

Newark, N. J. W. F. SCHAPHORST.



Belt tension in pounds per square inch may be determined directly from this chart as explained in the text.

ANSWERS *to* QUESTIONS

Trouble with Mica V-Ring of Commutator

On the commutator of one of our motors there is a space of 0.015-0.020 in. between the mica cone and commutator bars, and between the mica cone and V-ring, into which oil and carbon dust find their way and cause grounds and short-circuits in the commutator. I do not dare to draw the commutator bolts any tighter, for fear of breaking them or stripping the threads. We cannot spare this machine long enough to tear the commutator down; so I should like to know if there is any other way in which this trouble can be cured. I have tried to stop these crevices with shellac and a band of mica, but have no been able to effect a permanent cure. Is there any material that could be forced into these cracks to seal them?
Albert, W. Va. **F. H.**

IN ANSWER to the question by F. H., I have used the following scheme very successfully to solve nearly the same trouble. The machine that was repaired has worked satisfactorily for several months.

Take two parts of plaster of paris, one part of powdered mica, and enough glue to make a thick paste. This should be forced into the cracks with a thin piece of hard wood that will also go into them. The compound should be forced in as far as possible. After it is applied it will dry quickly and assume about the same degree of hardness as the mica cone. F. W. KUTIL.
Woonsocket, S. D.

AS a result of my experience with railway motors I would suggest that F. H. use two materials manufactured by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. One of these is known as No. 5 cement and the other as No. 513 compound. It is important that the directions on the cans be followed carefully.

When applying these materials I allow the armatures to stand for one hour, so that the compound will have an opportunity to become thoroughly dry. W. D. WALTON.
St. Joseph, Mo.

REGARDING F. H.'s question, a good commutator cement could be forced into the cracks and the V-rings, etc., painted with the new red oxide paint on the market.

A mixture of plaster of paris and shellac, of about the consistency of a heavy paste makes a good cement.

The trouble appears to be wrong machining of the V's in the commutator. This would be the case if a set of assembled segments had been installed and the old metal rings used; the V's on the assembled segments might have been machined improperly.

I would suggest that F. H. check this point and if such is the case, a special tapered mica V-ring or cone could be made special and installed. This would be the next best step to installing a new set of segments.

If this machine is very important and not too large it would be good policy to purchase a complete new spare armature, install it, and then fix the defective one.

Any patching done to this motor in its present condition will be only temporary and inviting a serious breakdown, as loose bars, high mica, grounds, shorts, and a roasted winding are likely to be the outcome of any patch job. A. C. ROE.
Wilkinsburg, Pa.

Flooring for Acid Conditions

What types of floors have readers found to be most resistant to acid conditions? In one of our departments considerable amounts of nitric and sulphuric acids are used. Some acid is splashed on the floor and, although it is well diluted with water, it is strong enough to attack wood, so that within a comparatively short time a wooden floor is rotted out. Painting does not stop this action, although it retards it somewhat. We tried putting a coating of asphalt over a wooden floor, but the results were not satisfactory, as the asphalt bulged out and pulled away in numerous places. We have thought of using a brick floor, but do no want to incur the expense of laying it unless we are sure that it will solve the problem.
Elizabeth, N. J. **W. H. F.**

IF W. H. F. wants a good, acidproof floor that will last almost indefinitely he should put down a brick floor of acidproof brick pushed in hot asphalt as follows:

First, put down a concrete base 3 in. to 4 in. thick, according to the service, and when sufficiently dry mop it with hot asphalt, such as is used for laying a wood block floor, thoroughly covering the concrete. When this has cooled off so that one can walk on it, dip the acidproof brick in hot asphalt for half the thickness of the brick and shove up a joint, as shown in the illustration. If a full joint is not obtained pour in some of the hot liquid, but not too much at a time, or else it will cool and make it difficult to push a good joint.

The brick should not be pushed either straight ahead or sidewise only, but should be moved in a direction towards the corner so as to push up a joint on two sides of the brick. Push the brick up tight to avoid a big joint; should there be any voids where the asphalt did not come up to the top, they may be filled up with the hot liquid, using a tin can with spout. After the job is finished the superfluous asphalt should be scraped off to leave a clean brick floor.

There is a certain class of paving brick that will answer the purpose, but common building brick are of no use. Acidproof brick come in regular sizes, 4x8x2½ in. They also come in tile form, measuring 12x12x2 in. and 12x 1x1 in., and if heavy loads are not to be carried, these latter are strong enough, and make a good-looking floor.

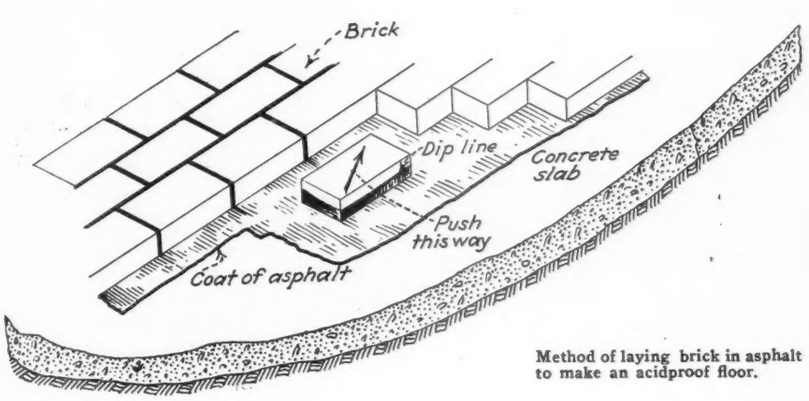
We have floors of the above type that have been in use for thirteen years, and are just as good as ever—with sulphuric acid running on them every day around our pickling pits.
Alton, Ill. L. KIPP.

IN answer to W. H. F.'s question, we have used a mastic, acid-resisting industrial flooring satisfactorily for a number of years in our plating department.

After the concrete floor has been waterproofed with wool felt and waterproofing cement, two layers of mastic, each ¾ in. thick, are applied hot (about 450 deg. F.). This mastic flooring consists of bitumen, white quartz, and asphalt flux and has been found to resist our acid conditions satisfactorily.

The first floor installed for us about ten years ago was found to be too soft under heavy trucking and hot room conditions, and became uneven. The floors installed later were given a different consistency; that is, more quartz was added, and after five years of wear they are still smooth.

This mastic floor, however, is not resistant to alkalies, and we have been forced to replace it with concrete where strong soap solutions are used.
D. W. INGALLS.
Oneida Community, Ltd., Oneida, N. Y.



Method of laying brick in asphalt to make an acidproof floor.

Fig. 1—Box-type and car-type furnaces for heat treating.

ELECTRIC FURNACES

with controllable atmospheres

By C. L. HEISLER, JR.
Industrial Heating and Welding Engineering Department
General Electric Company
Schenectady, N. Y.

MUCH study has been given to the subject of atmospheric control in furnaces for the purpose of producing certain desired results more economically than by methods formerly in use, or to meet the requirements imposed by the nature of new products.

Electric furnaces are particularly well adapted to atmospheric control and new processes have been developed in the laboratory and applied in the factory, which have revolutionized some manufacturing methods. An outstanding example is the copper brazing process, which today is being used by several concerns in the fabrication of metallic parts. By this process a large number of individual steel parts can be united into a complicated assembly at one operation, and by its use improvements in design at considerable savings in cost are frequently possible. Furthermore, certain fabrication problems can readily be accomplished by this process that would be impracticable or quite impossible by any other means. This process is carried out in an atmosphere of hydrogen, or in which hydrogen is present in substantial proportions, at a temperature slightly above the melting point of copper.

Atmospheric control, as practiced at the present time, may be indicated briefly by the following types of apparatus:

1. Normal atmospheres present in a closed heating chamber such as the usual electric furnaces used for heat treating steel. Apparatus employing this principle is illustrated in Fig. 1.

2. Atmospheres from which air is excluded as in sealed containers such as boxes or pots used for annealing steel wire or tool steel bars, to protect products from scale or decarburization of the surface.

3. Neutral atmospheres which do not affect, or materially affect the charge under given conditions of temperature, time, etc., such as an atmosphere of steam used in bright-annealing copper wire, or where the air in the furnace may be displaced by gases given off by the charge, as in annealing large masses of sheet steel in a closed chamber. Figs. 2 and 3 on the opposite page, show furnace equipment and material to be treated.

4. Carbonizing atmospheres in which the gas gives up carbon to iron or steel, as in case hardening. Hydrocarbon may be supplied in the form of gas; the container having inlet and outlet, or the steel may be packed in carbonaceous material.

5. Nitriting atmospheres, where the surface of the material is hardened by the action of the nitrogen from ammonia gas, forming iron nitrides. In this case sealed containers are employed with an inlet for the gas supply and an outlet for spent gases.

6. Oxiding atmospheres, as in japanning ovens, ovens for enameling copper wire, core baking ovens, etc., where fresh air is supplied to produce oxidized surface films, or

films between the grains of core sand.

7. Reducing atmospheres, such as the copper brazing furnace, suitable also for bright-annealing certain products. In this type of furnace the hydrogen acts as a flux, thoroughly cleansing all surface and reducing the oxides, if any. The atmosphere may also be diluted with a neutral gas such as nitrogen, if desired.

Normal atmospheres—In a closed heating chamber the atmosphere is made up of the entrained air and may be modified by the gases given off by the heated material. Practically all materials give off some gases when heated, the time and quantity depending upon the mass and nature of the material and the temperature to which it is heated. In the ordinary heat treating furnace, as in Fig. 1, the mass of the charge is small compared with the volume of the heating chamber, and the atmosphere is normal air, somewhat depleted of oxygen as heating proceeds, owing to some absorption by the material. In such a furnace, however, the atmosphere can be further depleted of oxygen by the introduction of carbonaceous material or a gas such as nitrogen.

Neutral atmospheres—Atmospheres of superheated steam as used in furnaces for bright annealing copper wire, effectively exclude air, and protect the material from oxidation. The work produced is as bright and clean as when put into the furnace. A very slight pressure is maintained in the furnace and is relieved by an inclined flapper valve.

The furnace is located over a pit containing water, with the opening in the bottom of the chamber, and having an extension flange projecting below the water level. The work is put in and taken out under the water seal by a suitable elevator.

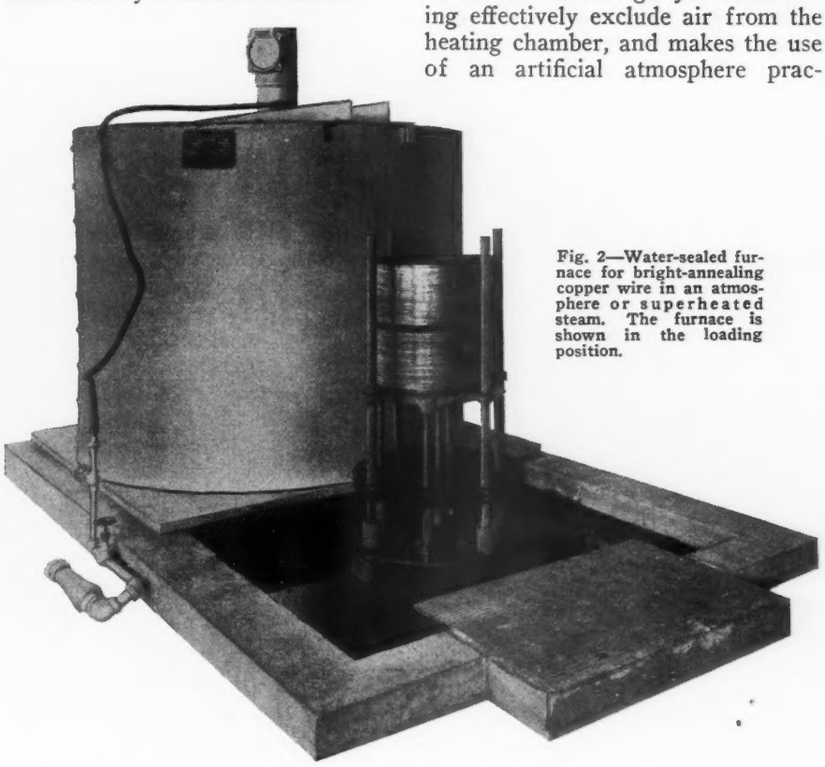


Fig. 2—Water-sealed furnace for bright-annealing copper wire in an atmosphere or superheated steam. The furnace is shown in the loading position.

The type of furnace shown in Fig. 3 is particularly adapted for annealing steel products in large quantities, and is used for such materials as sheets and punchings for electric machines, disk wheels for automobiles, gear blanks, and castings. It is known as the elevator type.

It consists of a chamber with the opening at the bottom, mounted on legs at an elevation above the floor, and arranged to permit a car to be run under the furnace on a platform, which is to be raised into position by a hydraulic cylinder or other suitable means. Seals around the edge of the car and a tightly-welded casing effectively exclude air from the heating chamber, and makes the use of an artificial atmosphere practicable, if desired. In such furnaces the loads are large in proportion to the heating chamber, leaving comparatively little space for air. When the mass is heated the gases given off completely displace the air, as shown by the analyses of samples of the furnace atmosphere given in the table on the following page.

It will be noted that the oxygen

Fig. 3—Elevator-type furnaces for annealing sheet steel.

disappears quickly, owing in part probably to small amounts of oil on the surface of the sheets. The nitrogen content increases rapidly.

Composition of Atmosphere in Furnace Annealing Sheet Steel in Bulk

	Soon after starting Pct.	At end of 6 hours Pct.	At end of 10 hours Pct.
Carbon Dioxide	6.2	8.7	8.0
Oxygen	0.15	0.1	0.0
Carbon Monoxide	24.5	14.4	13.75
Methane	8.0	0.0	0.0
Hydrogen	39.1	8.0	5.7
Nitrogen	22.05	68.8	72.55

Reducing atmospheres—Hydrogen is a strong reducing agent and is widely used in laboratories and in some industrial applications, but there are many who do not fully appreciate the practical advantages to be gained by the use of hydrogen in atmospheres of furnaces of production size.

Hydrogen reacts readily with many other substances, particularly at high temperatures. For example, with oxidized iron parts introduced into a furnace having a hydrogenated atmosphere, the oxygen in the iron oxide combines with the hydrogen to form water vapor, leaving the iron, when removed from the furnace, bright and free of all oxide. Advantage is taken of this fact in the copper brazing furnace. The hydrogen acts as a flux, cleansing the surface while the material is being heated, and when the melting point of copper is reached (1,083 deg. C—1,981 deg. F.) the fluid copper spreads over the surfaces and by virtue of their cleanliness is drawn into the joints between the parts by capillary action. The copper film so produced makes an exceedingly strong joint, of neat appearance, and dozens of parts can be united into an assembly at one operation.

The work requires cooling in a hydrogenated atmosphere also, and this requirement necessitates a cooling chamber contiguous with the heating chamber.

This process is applicable to large as well as small parts in quantity production, and furnaces can be designed to meet any requirements. Fig. 4 shows a large, continuous tunnel-type furnace with charging and discharging elevators at the ends. The work is carried through in pans or trays on a roller track, the line of trays being pushed by a hydraulic cylinder. This process has been eminently successful and a considerable number of furnaces, of various forms, are in operation.

When using the hydrogen atmosphere furnace, the reaction of hydrogen with other substances such as carbon should be considered. The hydrogen readily combines with carbon and when carbon steel is introduced into a hydrogen atmosphere, the oxide is not only reduced but the steel is decarburized or the carbon content of the surface metal is reduced. The amount of decarburization depends upon the time of the exposure, the pressure, and the temperature. If a low carbon steel is used for the parts to be brazed, and the time of exposure is short, the decarburization of the steel will be slight, and for most practical purposes negligible in effect.

Intelligent maintenance of plant equipment is always predicated by an intimate knowledge of the functions of the equipment in use. To enable plant engineers to become better acquainted in this field this article treats of electric furnace equipment and atmospheres in general. A succeeding article will discuss design and operation of furnaces.

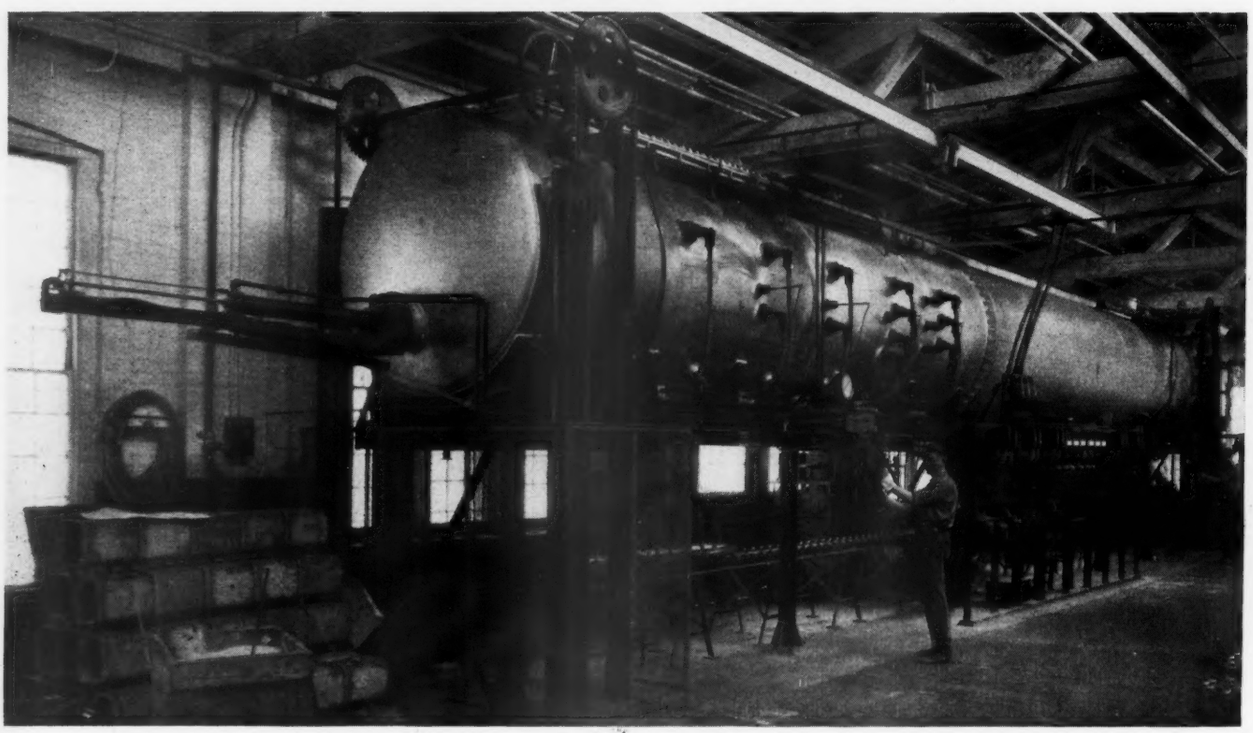


Fig. 4—Continuous tunnel-type furnace for copper-brazing steel parts together in an atmosphere of protecting gas.

PLANT · ENGINEERS' · FORUM

Heretofore *"Are You Ready for the Question?"*

* * *

Here is the eighth of a series of questions, each of which has at least two sides. A new question will be presented next month, and our readers' answers to previous questions also will be published. Write down your opinions and send them to the editor. Answers published will be paid for at an attractive rate.

* * *

How Develop Key Men for Maintenance Work?

George Shipman and Frank Fulleger are taking the day off to call on the plant engineer of a manufacturing concern 100 miles or so distant from the seat of their own activities. Several matters are to be discussed, among them, we hope, some that will be revealed to readers of Industrial Engineering later on. In the meantime let's listen in on the two men as they drive along.

* * * *

"Too bad we have to use your big car, George. But the gentleman at the garage said he hadn't found the break in the ignition line on my coupe, so I had to phone you that it was out of commission."

"Makes no difference, Frank. We'll get there just as soon and somewhat more comfortably. By the way, does Jones have a real electrical man at his garage?"

"No, I don't think he does. Has what he calls all-around mechanics. Makes a point of it, in fact—says that any one of his men can do any job on any car. I notice, though, that Jones himself is pretty busy diagnosing troubles that his men can't quite dope out."

Shipman drove for some time in silence. Then: "I suppose either method—using all-around men—or specialists—will work in the auto repair shop, Frank, depending upon the size of the shop and the ability of the boss himself. But how about a real service station, where the work is to prevent breakdown, not repair it? And the industrial plant, where the same objective holds true? It's a rather commonly accepted procedure now to have one man head up the work of maintenance of mechanical and electrical equipment and buildings. In a plant of any size he's got to have specialists under him. There isn't any such thing as a maintenance profession or a training school for maintenance engineers. How are such men developed?"

"You've trained several crews, George, so you ought to know. What did you do?"

"For the most part I didn't train them—so you're wrong there. But I did have several good crews, just because I was lucky enough to have good plant engineers working for me; they did the training. Did it by main force, so far as I could see; just put the men on the job and pointed out the errors of their ways until in self defense they started to think."

"Guess I'll have to do something along that line soon," said Frank. "Perhaps I can sell the old man on the idea of a school. A friend told me the other day that he has secured splendid results by holding certain men responsible for certain groups of equipment. For instance, one man looks after the automatic telephone system, outside cable plant, x-ray equipment, buzzer, automatic call, and fire alarm systems. He is responsible for any failure which occurs due to neglect of routine inspection, as well as general upkeep, major changes, additions, and so on. As a matter of fact he does the routine inspection himself, but I can see how it would be O.K. for him to have an assistant do that work. At any rate the man he told me about is what I call a *key* man."

"The system's fine, Frank. But how else could it be done?"

"Oh, a number of ways. Suppose one key man had charge of all motors, another all communication equipment, still another all mechanical power transmission equipment, and so on. Or the work might be divided up by buildings. Or—"

"Guess that's all, old boy. Here's our destination," said George as he drew up in front of an imposing doorway marked, "General Offices."

* * * *

Around and about they went. But conversations go that way, naturally, and in George and Frank we have two normal plant men. From such conversations ideas, plans, and systems grow. Let the editor of Industrial Engineering have your discussion on what ought to be done and how to do it. Send your manuscripts during the next three weeks.

How should the work be allocated and the responsibility divided?

How should the men be trained for key positions?

READERS' ANSWERS

to previous questions

How Shall Equipment Be Purchased?

Question Presented in the February Issue

FEW items present more possibilities for savings and harmonious co-ordination of efficient plant operation than that of purchasing equipment. Too often little thought is given to the importance of survey, investigation, and study that should precede a purchase requisition not only for major equipment but for some of the so-called minor equipment and supplies. Equipment and installation for the most part are listed under the head of maintenance and, therefore, under the alibi of "keep the plant running," the path of least cost for like or better results is not always followed, much being left to the better judgment of the purchasing agent, who after all must rely upon the plant engineer or other point of origin of requisitions as to general information for proceeding.

It is often a question when certain pieces of equipment can be purchased as a unit whether it is economical to so purchase or not. In some types of intricate or special machines it is unwise to attempt jobbing or fabricating various parts or auxiliaries if best results are to be expected. In other instances savings may be accomplished by so doing. I have in mind one piece of machinery which was purchased as a unit. After its installation it was evident that some of the auxiliary parts and supplies, if fabricated within the plant, would have saved the purchaser several hundred dollars. Needless to say future replacements in this case were made within the plant. In another case a machine purchased as a unit was delayed in shipment for several weeks, at a time when badly needed, due to the fact that its manufacturer was awaiting arrival of a specific motor for mounting. After considerable correspondence the unit was shipped without the motor and one on hand was used with complete satisfaction. It must be conceded that this delay could have been avoided. Of course the final decision of whether to purchase equipment as a unit or in part depends largely on the type of equipment and industry involved and upon facilities on hand for jobbing, fabricating or assembling as the case may be. Facilities for repairs and servicing are criteria that many times are not given the serious consideration deserved. Where special skilled labor or standard shop practice are affected probably differences in costs of keeping equipment in shape, when purchased as a unit or otherwise, must be analyzed and conclusions made accordingly.

Much detail and worry often are eliminated by letting one contractor or manufacturer take care of the entire assembly of a piece of equipment. There are certain merits to this policy. Invoices for equipment as a rule are not received until machines are practically ready for installation and productive operation. When purchased helter-skelter often months go by before the final piece has been received and the unit put into operation. Meanwhile parts which were delivered promptly have long been paid for, and capital has been tied up unnecessarily. On the face of it this may seem a rather small item but it is generally larger than it seems. A certain manufacturer recently making a survey of this unnecessary evil discovered that on the average about three to five thousand dollars worth of equipment parts in this class were being carried along continually—the equivalent of interest payments on a working capital of between fifty and eighty thousand dollars.

Where several manufacturers contribute to the assembly of a unit it is hard to place responsibility for its operation as a whole. It is for this reason that many establishments will more readily service units only when furnished as such. On the other hand the unit manufacturer or jobber (for lack of a better name), cannot always visualize the details to be encountered in actual operation. The writer's attention was recently called to a unit installation that was carried out to the letter as recommended by the contractor, even against the better judgment of the purchaser—only to be changed after its installation at an additional cost of several hundred dollars. As a rule failures such as this may be covered by proper guaranty as to results but not as to probable loss in production and increase in overhead.

In new installations of plant layout of considerable magnitude it is generally found desirable to plan and assemble, as far as practical, within the plant—although very often desirable to have the service of supervision or inspection by the manufacturer after installation. This procedure not only insures proper installation but also serves as an invaluable aid in future servicing and maintaining of equipment. Here again must be considered the cost of assembling and auxiliary parts, especially in the case of special equipment, as compared with complete unit installation. Major items for consideration here are skilled labor, cost of purchasing parts and auxiliaries in small lots, and fabricated facilities.

One thing which I feel is worthy of special mention is that of purchasing through one who is a direct representative of the factory or manufacturer, rather than from a Jack-of-all-salesmen. This applies whether it be a complete machine unit or special part. On a recent installation involving several variable speed drives a direct representative of the manufacturer showed how some unused drives on hand could

be altered at a very nominal cost to meet the new requirements. Representative of the other type saw no way out but to purchase new drives. This bit of information saved the company involved some six hundred dollars.

Another item worthy of being guarded against by the plant engineer is that of placing undue reliance upon newly developed projects widely advertised but, when investigated, found to be still in the laboratory or at least not as yet on a production basis equal to demand. By this I do not mean that one should not be always wide awake to the ever increasing new developments and contributions to industry—far from that. However, when an order is placed with the expectation of reasonable delivery, only to find that several months must elapse, it adds another picture of possible shutdown and tie-up capital.

Purchasing plant equipment and parts cannot be done in "The One Best Way." Intelligent purchasing of plant equipment is one of individual treatment and almost perpetual study by the plant engineer and his assistants or whoever has this responsibility.

H. L. SCHULTZ, *Asst. Supt. of Maintenance*
The Carborundum Company, Niagara Falls, N. Y.

THERE is of course much to be said for buying the whole job complete as a unit. There is no division of responsibility, and if the equipment does not operate as it should there is no opportunity for buck passing. The problems of installation, erection, or whatever it may be, are simplified on a large job. In many cases the detail engineering is simplified and almost all drafting eliminated. On the other hand, there are serious disadvantages. Unless the plant engineer sticks rigorously to shop standards as to motors, his investment in spare motors must become utterly unreasonable, or else he must sacrifice insurance against delay to an extent which cannot be tolerated in a large, close-coupled manufacturing plant.

Similarly, let us say that the group shafting hangers and countershaft bearings of a plant have been changed to antifriction bearing hangers. A few plain bearing countershafts in each manufacturing room would require the re-establishment of the old system of oilers making rounds every week or two. To be sure there would be fewer bearings to oil, but the route would be just as long.

The supplier will accept an order, specifying certain details to conform to shop standards, but in all too many cases he worms out of the requirement later, often on the threat of prohibitively long delivery, far in excess of promised delivery.

One of the best methods of solving this difficulty, particularly as to motor standards, is for the purchaser to ship the motor to the machine manufacturer's factory to be mounted by him on the driven machine.

There is so great a variation in types of material and equipment purchased, and in circumstances and conditions in the purchasers plant and organization that there is no "one best way."

Even in the same organization it may be best at any time to purchase "assembled" equipment, such as conveyors, as a unit, even "delivered and erected" if the plant engineering department is busy with major changes, and all supervisory and service departments are overloaded. The exact opposite might be best were the millwrights slack and in need of work to hold together a skeleton organization.

ROBERT W. DRAKE, *Consulting Engineer*
International Harvester Company, McCormick Works

Who Shall Do the Salvaging?

(Question Presented in the December Issue)

THE manager, superintendent, master mechanic, and the foreman of the department where the machine is used all should be consulted before the old machine is scrapped and the new one ordered.

When it finally has been decided to scrap the old machine, the maintenance department should have charge of the work, and all the standard parts which are in good repair should be put into the stock room, but separate from the new stock. The maintenance department should then have the say as to whether the store keeper shall issue new or old stock.

Some managers object to scrap piles and insist scrap be disposed of a ton or two at a time. This no doubt is the proper procedure in the middle and eastern states where quick delivery on repair parts is possible. Out west, especially in saw mill and mining camps, a scrap pile often becomes a valuable asset. But if accumulation were permitted all over the country there would be millions of tons of metal lying idle which could be recast into valuable modern machinery.

One of the principal objections to an accumulation of scrap is that it never looks neat. You cannot even pile it.

M. B. KRAMER, *Chief Engineer*
El Paso Milling Co., Ltd.
El Paso, Texas.

THERE are many Frank Fullegers in industry who complain because the boss has told them to clean up some phase of their work. If Frank were on the job as he should be, he would sit down and plan out his work, then delegate some capable man under him to look after that particular phase, holding him in turn responsible for the results.

A salvage department (even though consisting of only one man) is in the best condition, because of constant performance, to look after this class of work. Such a department can find or create an outlet for the goods which have been salvaged.

Machine tools that have become obsolete or worn out should be junked as a whole, unless other equipment of similar design is in use, in which case it should be dismantled. Parts that can be used in the repair of other machines should be reconditioned and placed in the maintenance department stock.

Floor sweepings, contents of blower dust containers, broken wooden boxes or barrels, and all rejected material throughout the plant should pass through the salvage department. If the sweepings are passed over a magnetic belt conveyor all iron and steel parts, such as chips, bolts, nuts, washers, etc., will be separated. Threads of bolts can be re-chased and the bolts placed

in bins for use by the maintenance department. Chips can be bailed and sold, after extracting the cutting oils. The dust from polishing or grinding can be remelted, or in the case of zinc or aluminum can be used as a base for protective paint for exposed metal parts.

In general, such a department hinges, for its successful operation, upon the right man for the job. The extreme economist type, who can't pass by a pin on the floor without picking it up, should be chosen. Then after proper training he can dispose of his salvaged material to the best advantage with a profit to the company. The man in the shop who is schooled to save all his waste material and turn it over to the salvage department will unconsciously begin to look for ways and means of cutting down his percentage of scrap.

From this standpoint of turning your salvage job over to a specialist the Frank Fullegers of industry can accomplish this undesirable job in a desirable sort of way.

MERLYN F. STEPHENS, *Industrial Engineer*
Precision Castings Company, Inc.
Fayetteville, N. Y.

THE decision as to whether a machine should be scrapped or renovated is distinctly the duty of the electrical and mechanical chief, whatever his title may be. He is held responsible for the operation and maintenance of all equipment and is the one man in the organization best fitted to pass on salvage questions.

As soon as possible after a machine is put "on the dock" he should decide its ultimate disposal. While the method of attack may vary, in a general way, it will be about as follows.

The machine should first be given a general inspection, in order to determine the most obvious defects. In the course of this inspection it often develops that the machine should be scrapped, either on account of the evident cost of repairs or the fact that it is wholly, or in part, obsolete. In this case the machine should be dismantled and broken up for easier disposal. During this process it will often be found that parts of the machine are in good condition, or can be put into serviceable condition at a small cost. These parts should be salvaged, renovated, and put in stock for use as repairs for other machines of the same type. In passing, it should be noted that parts for a certain machine, more frequently than one would suppose, are duplicates of parts for a different machine, even if manufactured by a different concern. An alert supply clerk, or the electrical and mechanical man, will know about these cases and be on the lookout for such parts.

When all usable parts have been salvaged, the balance goes to the junk pile, different metals being segregated to facilitate their eventual sale and shipment.

The renovated parts are placed in stock and reissued as needed. Local rulings must govern the price placed on them, the writer's method being to carry them at the cost of salvaging plus an arbitrary percentage to cover overhead, which figure can usually be arrived at by means of a conference with the works auditor.

If the initial inspection shows that the machine can be put in good order by replacing a few parts or by a more extensive overhauling, the electrical and mechanical man must decide between two courses of action. He must compare his estimate of the cost of this work with the price of a new machine, should the necessity arise for one of that type, and decide which will be the more economical.

In making this decision he will have two rules for his guidance. The cost of labor and material must be below 50 per cent of the cost of a new machine and the indicated work must be well within the capabilities of his men and the available equipment.

The second rule is self-evident, but the first may need a little explaining. That's easy. Overhead is the answer. If every maintenance chief remembered that every dollar spent for labor and material had its twin brother in overhead expense trotting along at its side, a lot of renovation work would be dropped and the machines scrapped.

If, after taking account of all these factors, the renovation job is decided on, the actual work can usually be done with no increase in the personnel of the maintenance force. This is due to the fact that very few maintenance shops are worked continuously to their limit of capacity and a salvage job nearly always can be kept under way as a "stand-by" job, to be worked on whenever a lull occurs in the routine work. This method is also facilitated by the fact that equipment "on the dock" is not likely to be called for without ample notice.

R. R. SCHELLENGER, *Master Mechanic and Chief Electrician*
Lafayette Fluorspar Company
Mexico, Ky.

LUMBER SALVAGE records at the Schenectady plant of the General Electric Company show that, for the first nine months of 1929, 2,166,981 board feet of lumber having a value of approximately $65,000 was salvaged. The Schenectady plant maintains a salvage lumber yard to which is consigned all waste lumber varying in size from heavy timbers down to crating scrap. Two buildings have been equipped with machinery which turns old timbers and heavy pieces into lumber of useful sizes, which in many instances obviates the necessity of using new lumber. Smaller pieces are used for making crates and tote boxes.

Who Shall Do the Oiling?

(Question Presented in the November Issue)

IT is my opinion that the oiling should be done by a lubricating gang in charge of the plant maintenance department.

Under the old system of having an apprentice or low-paid laborer do the oiling, many bearings and journals were burned out for lack of oil or grease, causing, in some cases, disastrous fires and loss of property. On the other hand, where he did oil, he would usually flood the journals or cause great "gobs"

of grease to fall down the operators' shirt collars—and worse, the grease had a great affinity for the master mechanic's, or manager's, head when he came through the shop, an experience we have all gone through in a not so very remote past.

Nowadays, modern journals and inclosed transmissions, with efficient lubricating systems, are installed, eliminating the old fire and safety hazards caused by overheated bearings and grease or oil on the floor,

The "oiler" is no longer an oiler, but a lubricating expert. He knows what is the need of each revolving or moving part where friction exists. He is no longer the black, dirty and greasy oiler of old, but is as clean and neat as any respectable mechanic, these changes being due to modern lubricating equipment.

The lubricating gang should lubricate both the transmission and production equipment at least once in eight hours of productive time, the frequency depending upon the speed and class of machinery used; but the production department should share the responsibility of keeping production machinery lubricated, especially when there are revolving parts needing lubrication frequently.

M. Peterson, *Plant Department*
Western Electric Company
Emeryville, Calif.

THE correct lubrication of plant equipment is a vital necessity in the operation of the industrial plant of this age. Production lines can be crippled, stopped, and general havoc can be raised by dry, or burned, or frozen bearings. Almost always, when one of those things happens, the cost far exceeds what it would have cost to provide the correct lubrication means and to place the maintenance in charge of a competent plant man who would keep thoroughly posted on the subject.

The average person today is acquainted with the modern, easily applied means for high-pressure lubrication for his automobile obtainable at filling stations and garages. The business these stations do should prove that the station method is cheaper than attempting to do the same job by hand at home. We also know that the life of the automobile engine is lengthened by the oil filters used. So it surely leaves little room for argument about applying the same schemes to our industrial plants.

Operators of factories which are on piece work or bonus, or other incentive plans, are so engrossed with obtaining their mark that they can't remember to attend to oiling their machines; besides, too many people attending such a job always leads to neglect.

In our plant we employ a man especially for the work of lubrication, and as he does his task in each department the foreman co-operates with him. When the wheels aren't turning he gets at all the places that can't be oiled during operation.

The procurement of proper equipment, together with the correct oil, grease, graphite, etc., is up to the purchasing agent, who consults the factory super.

Chas. H. Willey, *Asst. Plant Superintendent*
Hoyt Electrical Instrument Works
Penacoak, N. H.

Who Shall Do the Welding?

(Question Presented in the September Issue)

THERE are different types of welds and different methods are required to make them. The type of weld used on one break may not be suitable on another. For instance, there are cases where it is impossible to make an electric weld, while again nothing but an electric weld will do. In order, then, for an industrial plant to do all of its own welding it is necessary to be equipped with both electric and oxy-acetylene outfits.

In a large plant, where outside repair bills would run high and shutdowns are costly, also in industrial plants that are isolated, whether large or small, such equipment is justified.

Where the welding is of such a nature that most of it can be done by an oxy-acetylene outfit and the welder kept comparatively busy, that plant is justified in doing what repairs can be done by this means, letting the repairs which must be done by means of the electric arc welder out to contract shops.

In a large industrial plant, where breakages are heavy and where the plant not only does all repair work but its own construction work as well, two outfits are justified. One operator can handle either outfit and when not engaged on repair work can be doing such jobs as may crop up in the course of plant operations and new construction work. Any number of such instances might be mentioned, such as making up stair railings, safety railings around dangerous machinery, pipe joints, steel trusses, and so forth.

In addition to welding, there must be considered the advantages gained from using the outfit for cutting and burning.

Another instance, where the cost of maintaining welding outfits may be reduced to a great extent, is where the plant is in proximity to other plants which are not equipped. Rental of equipment and profit from labor will amply repay for the original investment.

Where an industrial plant cannot keep a skilled operator constantly employed and contract shops properly equipped are available at all times, it will be found considerably cheaper to have the repairs done by the contract shop.

Most boiler and machine shops these days are equipped with both electric and oxy-acetylene portable outfits, which can be easily taken from place to place. These shops are a boon to not only the smaller plants but the larger ones in their vicinity, since their skilled welders are always available to help out in a necessity.

Welding is no harder to learn than any of the other trades. In fact, any careful mechanic may quickly pick up the necessary knowledge, if he uses common sense and profits by experience.

Experience is of vital importance in making different kinds of welds. A welder must know what metals will not readily weld, what heat to apply to various parts, and how to regulate the cooling off. This knowledge can be gained better by experience than by any other means, the same as a blacksmith learns to temper and weld metals.

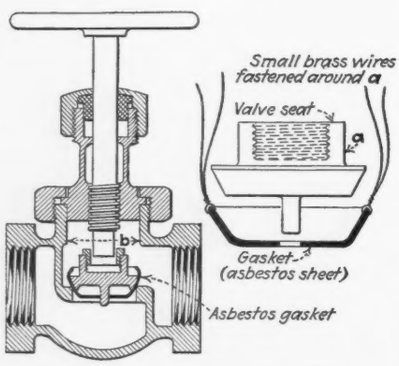
H. E. Stafford, *Electrical Engineer*
Port Arthur, Ont.

AROUND *the* WORKS

Emergency Repair for Globe Valve

WHEN no valve reseating tools are at hand the ordinary globe valve may be made to hold in the following manner: Obtain a small piece of asbestos gasket material (rubber sheet may be used but will not be as permanent as the thicker material) and cut it to form a disk a little larger than the valve seat. To the opposite edges of the gasket attach a loop of fine brass wire to bind around the disk *a*, in the sketch; this will hold the gasket in place.

The valve seat with gasket attached may have to be forced through the opening in the valve body marked *b*, but after passing this point it will operate freely.



A circular piece of asbestos gasket material is attached to the valve disk, to form a new seat.

This repair is not recommended for permanent use, but it will be found to give satisfactory service in emergencies, especially where the valve is used only occasionally.

Magnolia, Miss. W. T. CLAYTOR, JR.

Method of Figuring Materials for a Concrete Job

EVERY plant engineer has numerous concrete jobs for which materials must be supplied, and the question invariably comes up as to how much of the various materials should be purchased for the job. Oftentimes one will hunt through several handbooks, spend some time figuring and making a guess, and eventually find out that he has either run 'way over on some materials and short on others, or has ordered so much that he has some of each kind of material left over. In any case the cost of the job goes up.

The most economical way all around is to order just sufficient material to complete the job, and then the job costs will show up right.

Aside from these considerations it is a decided advantage to be able to determine quickly beforehand the quantities of each material required. Estimates must be made up and one likes to have his estimates come out about right. I have found a table such as the one given herewith an invaluable aid in insuring accuracy in my estimates, as well as when ordering materials.

QUANTITY OF MATERIALS REQUIRED FOR ONE CUBIC YARD OF CONCRETE

Cement	Mixture Sand	Gravel	Sacks of Cement	Yards of Sand	Yards of Gravel or Rock
1	1.5	0	15.5	0.86	0
1	2	0	12.8	0.95	0
1	2.5	0	11	1.02	0
1	3	0	9.6	1.07	0
1	1.5	3	7.6	0.42	0.84
1	2	3	7	0.52	0.78
1	2	4	6	0.45	0.9
1	2.5	4	5.6	0.52	0.83
1	2.5	5	5	0.47	0.94
1	3	5	4.6	0.51	0.89

H. C. CHARLES.

Air Injection of Low-Pressure Steam

IN industrial work it is often desirable, if not at all times necessary, to heat by means of jet condensers. One such application is water heating, where by the use of the jet condenser water is added to the vat by way of the condensate. Wherever possible it is considered best practice to install a coil and return the condensate to the power plant by means of an adequate vacuum return system. This is particularly true where the power plant is operated condensing and high economies are sought. The power plant will register some very stiff objections to the use of a jet condenser in manufacturing operations.

However, jet condensers are often found in various industrial operations. On several occasions I have seen jet condensers working on 3 lb. exhaust steam; that is, they were trying to work, but, of course, were not at all successful. In one place, however, a very ingenious contrivance was in use. For a better name I will call it an air injector.

This jet condenser job was on an oil reclaiming unit in which the oil was heated, and it was necessary to introduce steam in order to carry off the gasoline dilutant. The oil was heated by a coil. The condensate from this coil was trapped back to the condensate return lines. Only exhaust steam at 3 lb. was available, and the jet condenser would not work on this pressure. It was contemplated to run a high-pressure steam line to the unit in order to make it possible to remove the light ends of gasoline.

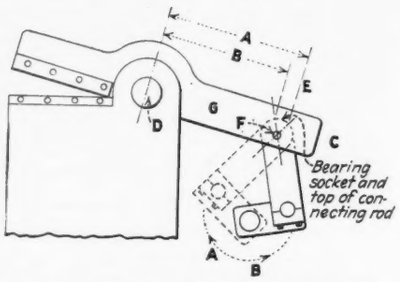
Before doing this it was decided to try to introduce the low-pressure steam by the injection principle, using high-pressure air for the purpose. Accordingly a ¼-in., high-pressure air pipe was fitted into a 1-in. tee. The ¼-in. pipe was provided with a running thread and the end allowed to project slightly beyond the 1-in. branch line which was connected to the low-pressure steam line.

By turning on the air just slightly sufficient low-pressure steam was introduced to do the work, and the oil reclaiming went along without further trouble.

Waterloo, Iowa H. C. C.

Capacity of Shears Reduced by Wrong Direction of Rotation

SOMETIME ago I was called to find out why a scrap-cutting shear of the alligator type failed to cut scrap metal of certain dimensions, which it had done so without the motor showing signs of distress until recently. The motor had been completely overhauled, new bearings installed, the windings washed and varnished, and it was to be expected that the performance of the shear would be improved; instead it was decreased 50 per cent.



The dotted outline of the crank and circle A indicate the position of the connecting rod and crank at the beginning of the cut.

After an investigation, my attention was attracted by the socket design of the connecting rod, shown in the illustration. The fact that the motor had been disconnected and that it could have been hooked up to run in the opposite direction led me to determine the cause of the trouble.

The illustration shows how the leverage is decreased when the crankshaft is run in the direction indicated at B. Pin *F* at the top of the connecting rod is a loose fit and is used only to pull the lever down, whereas during the cutting stroke the force is applied to lever *G* by the connecting rod through the socket joint bearing *C*. Reversing the direction of rotation of the motor restored the shears to its normal capacity.

Chief Electrician, J. F. WISINSKI.
Ladish Drop Forging Co.,
Milwaukee, Wis.

BEARINGS—*Choosing and Using Them for Power Transmission*

By WILLIAM STANIAR

Mechanical Power Engineer
E. I. duPont de Nemours & Company, Wilmington, Del.

POWER transmission bearings serve to support revolving shafting on a lubricant film or on a mechanical medium, such as a ball or roller. Selection of bearings for transmission equipment should be based on the following factors:

1. Operating conditions
2. Lubrication methods
3. Location and accessibility
4. Manner of support
5. Speed and diameter of shaft
6. Direction of load
7. Initial and maintenance costs

These factors are so important in securing economical and efficient bearing operation that they will be discussed separately.

All bearings are seriously injured by the action of such atmospheric elements as dust, grit, steam and acid mists, and mechanically by vibration, misalignment, and irregularities of shafting. These elements and defects cause rapid deterioration of the lubricant, resulting in premature failure of the bearing metals and rapid destruction of any anti-friction medium.

Sulfuric acid is particularly harmful to a lubricating oil because it has a precipitating action on certain hydrocarbons in the oil, which is not only ruinous to the lubricant but also causes pitting of the journal.

The usual babbitted bearing is not designed to prevent the entrance of dust and gases; therefore, ignorance of the provisions made to protect certain types of babbitted bearings, coupled with the consideration of first cost only, result in many cases in premature failure and high maintenance costs. In the anti-friction type of bearing the designers have always considered this important point, with the result that all such bearings are designed to exclude deleterious gases and abrasive foreign materials.

The mechanical defects detrimental to efficient bearing operation can be overcome if the engineer uses good judgment in the selection of the immediate support for the bearing. The ball-and-socket, spherical, or four-point suspension design of hanger frame or pillow block, and the self-aligning feature of the modern anti-friction bearing are avail-

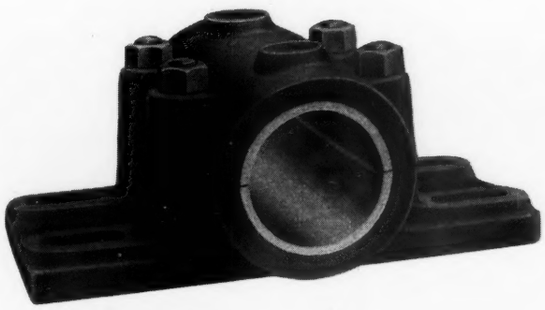


Fig. 1—Regular babbitted bearing designed for hand oiling or grease cup lubrication.

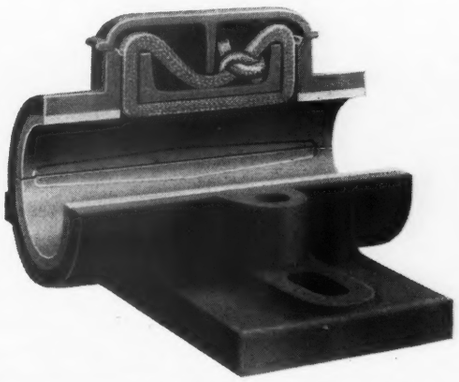


Fig. 2—This form of babbitted bearing utilizes a wick as the medium for feeding the lubricant to the shaft.

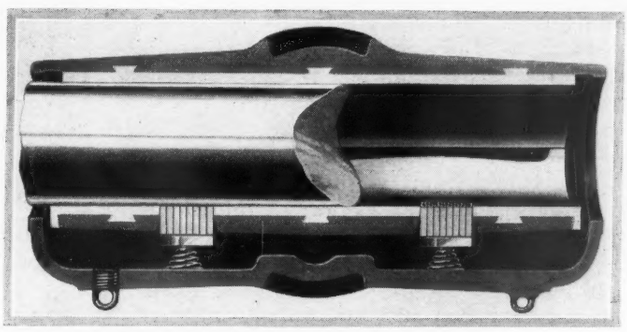


Fig. 3—The self-oiling babbitted bearing known as the capillary-oiling box. The slotted wood blocks transfer oil from the reservoir to the shaft by capillary action.

Fig. 4—Self-aligning, ball-bearing lineshaft bearing, in adjustable hanger frame.

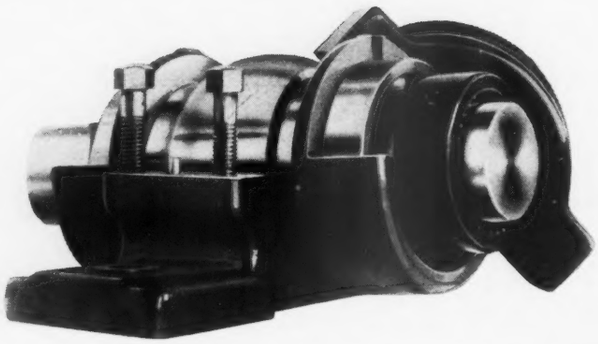


Fig. 5—A modern type of self-aligning, ball-bearing pillow block.

able for the elimination of these difficulties and should generally be employed where there are three or more bearings used on line- or counter-shafting.

Bearings without an adequate lubricant film surrounding the shaft or journal are valueless; hence, many methods have been devised to spread such a film properly over the entire bearing surface. Several designs and styles of babbitted bearings are available, a typical design of which is shown in Fig. 1. The actual difference, however, generally is in the method of applying and retaining the lubricating film. A common method of doing this in plain babbitted or brass bearings is to provide holes at the top of the bearing from which grooves project in the babbitt or brass.

The edges of the grooves are rounded to prevent a scraping action that would tend to remove the lubricant from the shaft, instead of building up a film. The best practice is to cut the grooves only on the side of the bearing where the pressure is not applied. The bearing should be properly grooved almost its entire length; otherwise, there may be oil only in narrow bands immediately under the source of supply.

In order to eliminate the frequent lubrication necessary with the plain babbitted bearing, the self-oiling bearing has been developed. This type will store enough oil for a considerable period of time, with a marked effect on consumption and maintenance. Use is made of the ring, collar, chain, wick or capillary block with bearings of this design. The first three types draw the lubricant mechanically from the reservoir to the shaft, whereas the latter two do it by capillary action.

The ring-oiling bearing is used extensively on small- and large-diameter transmission shafting at speeds up to and including 200 r.p.m. This type employs one or more rings which encircle the shaft and rest upon it, the bottom of the ring dipping into an oil reservoir under the bearing. For efficient lubrication the ring should have a surface speed of at least 50 f.p.m.

The chain and collar types function in practically the same manner as the ring, although at very low speeds, and for shafting of large diameter the collar oiling bearing is more frequently employed because it is capable of providing a greater flow of oil.

A modern form of wick-oiling bearing is shown in Fig. 2. The oil or fluid grease is placed in the top chamber; the wick becomes saturated and thus the lubricant is fed by capillary attraction to the shaft.

Another efficient and extensively employed type of capillary-oiling bearing is shown in Fig. 3. This type employs soft wooden blocks, each having a series of fine slots with the lower end immersed in a bath of oil and the upper ends pressing against the shaft. The oil rises through the slots by capillary attraction. The block is held in contact with the shaft by a spring. Such bearings are decidedly efficient at speeds above 150 r.p.m. and with shafting up to 3 15/16 in. in diameter.

Babbitted bearings, whether of the hand- or self-lubricating types, always present a problem because of the labor item involved in the daily oiling of the former, the frequent oiling of the latter, the actual cost of the lubricant, burned-out bearings, due to inattention, loss of production, and the possibility of damage to certain materials in the process of manufacture.

The anti-friction or mechanical bearing utilizes a ball or roller to take the slip between bearing and journal and requires a lubricant only to protect the surfaces of the races, balls, and rollers. In this type of bearing, friction is reduced to a minimum, lubrication difficulties are prevented, and it can be employed where inaccessibility is a necessity. These factors are responsible for the wide use of the ball and roller type bearing in power transmission mechanisms and mechanical devices generally. A demand for many designs

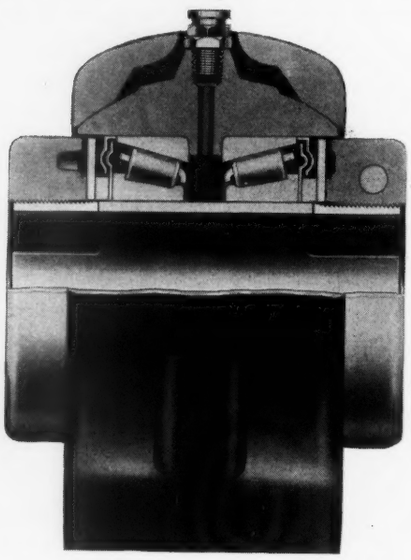


Fig. 6—A pillow block that utilizes the tapered roller as the anti-friction medium.

of bearing housings has been created and successfully met by bearing manufacturers.

The ball bearing is probably the most extensively employed in mechanical devices and special machinery, and is available for all styles of mechanical transmission bearings. The modern design of ball-bearing hanger shown in Fig. 4 compensates for shaft deflection through the self-aligning ball-bearing and, moreover, is capable of vertical adjustment.

Another efficient application of the ball bearing in the form of a self-aligning pillow block is shown in Fig. 5. This bearing can be used on short line-, counter-, and headshafts when supported from below, and particularly where accessibility is difficult to provide.

The tapered-roller bearing is newer in the field of power transmission, but is widely used. It is available in all styles of transmission shafting bearings and can be operated at speeds impossible with the babbitted type of bearing. The lubricant used is usually a light grease, which gives months of service from one filling. Fig. 6 shows a pillow block of the self-aligning type utilizing a tapered roller.

The flexible steel roller bearing designed for hangers, Fig. 7, and for pillow blocks, Fig. 8, are probably the most extensively employed for lineshafts because of their ease of application. The types of ball and roller bearings previously mentioned are of necessity solid; therefore, for replacement it is necessary to dismantle all shafting equipment.

The bearing shown in Fig. 7 is split and can readily be applied to existing shafting without the removal of any transmission appurtenance. The rollers operate in a steel casing, but actually contact the shaft and owing to their flexibility, adjust themselves to any shafting irregularities. This type of bearing is available in all styles for transmission purposes and uses a heavy oil as a lubricant. One filling is ample for a long period of service.

When three or more bearings are required on a line- or countershaft, the self-aligning support should be employed in the form of the ball-and-socket or spherical design. Owing to the irregularities of the average cold-rolled steel shafting and the possibility of structural settling, it is impossible to overcome continuously variations in alignment by any other means than the automatic aligning features of the types mentioned. Bearings of the rigid type should be used only where two bearings are adequate for the entire support, such as on head- or short line- or countershafts, because almost perfect alignment can be obtained by the aid of the wedge-design, adjustable baseplate.

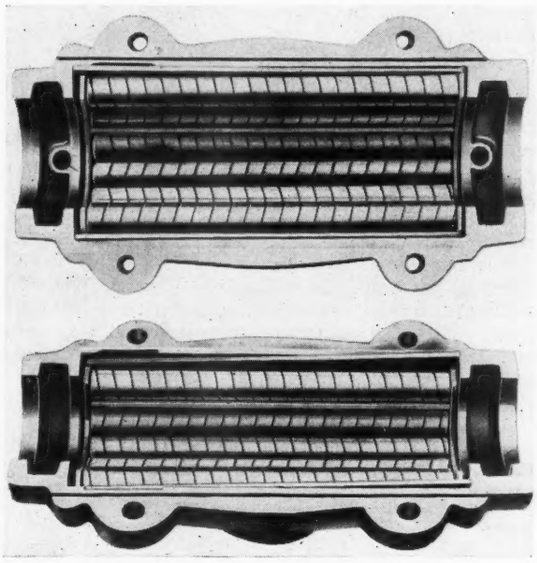


Fig. 7—Anti-friction lineshaft hanger box utilizing the flexible steel roller.

The speed in revolutions per minute determines the horsepower capacity of transmission shafting, and this factor, together with the dead load and belt or chain pull, determines the diameter. Therefore, these two factors should to a great extent govern the selection of a bearing. Industrial line-, counter-, and jackshaftings operate from 150 to 400 r.p.m. in sizes ranging from 17/16 to 2 15/16 in. diameter. For this service either the self-oiling babbitted or the ball or roller type box is entirely adequate, but for higher speeds the decision should favor the anti-friction bearings, because they eliminate the lubrication hazard.

Shafting operating at speeds below 100 r.p.m. and ranging in diameter from 2 15/16 in. upwards should be supported by bearings of the regular, babbitted, grooved type, lubricated by grease, either through the cup or pressure system. In the smaller sizes, or below 2 15/16 in. diameter, good results have been obtained with the self-oiling babbitted or anti-friction types at speeds as low as 50 r.p.m.; however, below this speed the common grease-lubricated box is preferable.

Generally the load pull in a bearing is either downward or at approximately 90 deg. to the center. Such a condition permits use of a standard bearing pedestal and cap design. There are occasions, however, where the pull is at an angle of 30 deg. to 45 deg. to the horizontal, upward, and in some cases directly vertical. Both conditions subject the cap, the weakest portion of the bearing to abnormal stresses and tend to retard the action of the lubricant. To provide against the difficulty involved with 30 deg. to 45 deg. load pulls, the angle, split bearing has been produced. It allows the base of the bearing to take its proportion of the upward pull.

Endeavoring to save money on the initial cost of bearings is poor economy because, like many other power transmission appurtenances, the best is none too good. As the transmission of power is so vital to production, so the bearing is vital to power transmission. Therefore, regardless of first cost the best should be employed for the atmospheric and mechanical conditions involved. Long life should be expected from good bearings properly and adequately lubricated. Initial cost savings are rapidly consumed in continuous maintenance charges, shortened life, and lowered production.

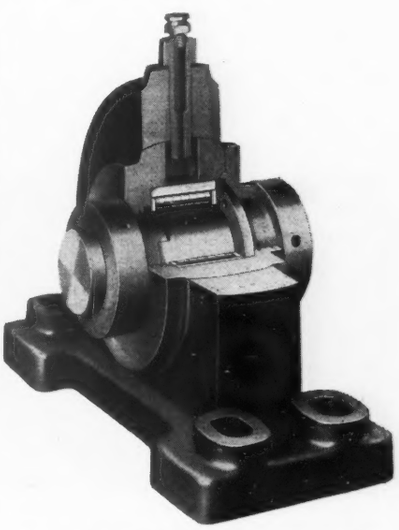


Fig. 8—An anti-friction pillow block of the self-aligning type that uses the flexible steel roller.

AROUND *the* WORKS

Unusual Way of Handling an Electric Melting Pot

IN our paper mill it is frequently necessary to rebabbitt jordan, beater, lineshaft, and other bearings that must be poured in position. In order to facilitate this work a portable electric melting pot has been obtained. A truck was constructed in the shops at small expense by taking four Ford front wheels, fitting the hubs to roller bearings and mounting them on an angle-iron frame. The tires consist of band iron shrunk on over the rims.

The axles are 1¼ in. square machine tool steel with tapered ends to fit the roller bearings. The framework, which supports the melting pot and electrical fixtures, consists of angle irons bent to shape. The front part is bent to allow a short turning radius. A platform is fastened on the rear end of the truck, between the two frame angles, and the electric melting pot is mounted on this. The control is mounted on a panel at the front of the truck.

One Sunday it was necessary to replace four jordan bearings. These bearings had to be poured in position, because they were the thrust bearings on the front side of the jordan.

On Saturday afternoon the electric melting pot was moved to the jordan room and prepared with babbitt. The automatic temperature control was set to the desired temperature, and instructions were given to the night watchman to turn on the switch at 4 o'clock Sunday morning. At 7 o'clock the workmen arrived, found the babbitt melted and the temperature, which is very important, at the desired point for pouring. Each bearing required 75 lb. of babbitt.

Inasmuch as the capacity of the melting pot is 150 lb., it was necessary to remelt another charge of babbitt in order to complete the job.

Two of the old bearings were dismantled and new ones were put in their places. After pouring these the electric pot was recharged with babbitt and while it was being melted, the men were engaged in scraping and cutting the oil grooves in the bearings just poured. The bearings were then assembled.

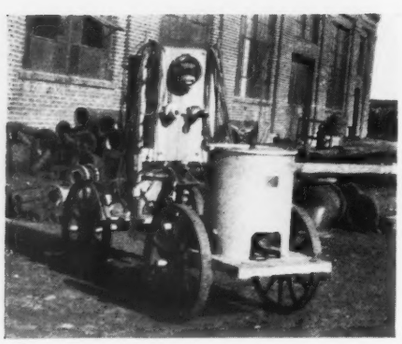
The last two jordan bearings were replaced by the two new ones. The babbitt that was placed in the melting pot the second time was now ready and being maintained at the desired temperature for pouring. The last two bearings were then poured and finished as before.

The old method of doing this work would have meant extra help to fire the furnace and watch the babbitt to keep it from over-heating. The only temperature control would have been a piece of paper or a pine stick, neither of which is accurate.

Another instance where the electric melting pot made a saving was in the babbitting of a step bearing for a machine in our power house. The melting pot was taken to the power house and the temperature control set just before the men left for the noon hour lunch. At 1 o'clock the babbitt was ready and the bearing was poured. Here again we eliminated the overtime expense of a man preparing the babbitt so that it would be ready to pour at 1 o'clock.

S. R. McSWAIN.

Mosinee Paper Mills Company,
Mosinee, Wis.



The 150-lb. capacity electric melting pot and control panel are mounted on a home-made truck for transportation anywhere in the mill.

Reducing Draft Improved Operation of Ovens

RECENTLY we discovered that by reducing the amount of air delivered to our enameling ovens we were able to raise the temperature in the oven 10 deg., even though the delivery temperature remained the same.

The enameling oven is of the bottom-entry, progressive type in which a maximum temperature of 430 deg. F. is maintained. Heat is supplied by a remote, oil-fired indirect heater. The distribution ducts are laid on the floor and are provided on each side with slotted openings that are baffled to prevent the air rushing out at the end. This duct is about one-fourth the length of the oven and is located beyond the center of the oven in the direction of the conveyor travel.

Ventilation is provided by a forced-draft stack at each end, and two natural-draft stacks, one on each side of the oven, are located at a point about one-fourth of the oven length from the entering end.

The only explanation we have to offer for the rise in the oven temperature is that at the higher velocity the delivery air induced a draft of cold air along the floor from the delivery end of the oven. This cool air mixed with the delivery air would give the resulting lower temperature.

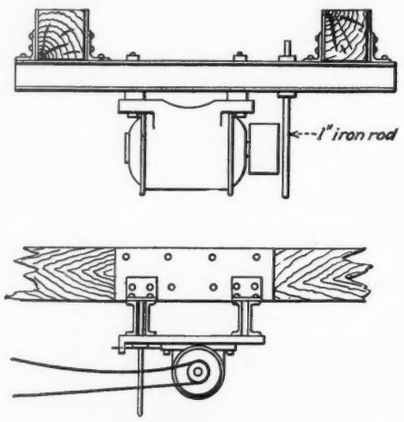
Such instances show the economy of employing intelligent oven tenders, as the reduction in the amount of air put through the system will not only effect a saving in fuel, but result in longer life of the heating and ventilating equipment. Furthermore, the reduced velocity of the air in the oven has brought about an improvement in the quality of the product, by decreasing the amount of dust stirred up.

Chicago, Ill. F. H. L.

Safety Bar to Prevent Belt from Running Off Pulley

VARIOUS schemes, some of which have been described in previous issues of INDUSTRIAL ENGINEERING, are employed to keep the belts from running off the pulleys of overhead motors, and causing damage to machines or injury to workmen, as well as loss of production.

I am in charge of a large number of motors, and many are hung overhead.



Safety bar to prevent belts from running off the motor pulley.

Some of these motors are of 50-hp. rating, and have a long and heavy belt.

The way in which I stopped the belts from running off and falling is shown in the illustration. An iron rod 1 in. in diameter passes between the supporting channel beams and is held in place with a nut and washer on both sides of the beam. The rod extends down below the lower edge of the belt for 6 or 8 in. and clears the belt by an inch or so, thus preventing it from running off and falling. When it becomes necessary to remove a belt or put on a new one, the rod can easily be moved out of the way by loosening the top nut and sliding the rod back.

In some installations, the supporting beams for the motor consist of a single I-beam, instead of two channel irons. Where this is the case, a piece of ½ x 1-in. iron bar can be bolted to the side of the I-beam, and will serve just as effectively.

Henderson, Ky. T. C. WITHERSPOON.

CHANGING MOTORS FROM TWO PHASE TO THREE PHASE

Points to be checked beforehand

By A. C. ROE

CHANGING a two-phase motor or generator to operate as a three-phase machine, can be divided into four steps: (1) Determining condition of present winding. (2) Determining type of phase insulation. (3) Reconnecting old winding. (4) Redesigning the winding and installing it. These steps are listed in the order of their importance in approaching any problem of this nature: that is, first, check to determine whether the present two-phase winding is in suitable condition to be used, if further checking indicates that the machine can be reconnected.

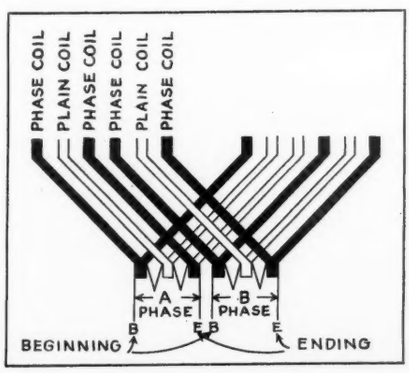


Fig. 1.—Two pole-phase groups of three coils each, with the coils connected in series. The black lines indicate the phase coils, which are located at the beginning and ending of each pole-phase group.

The object of this check is to decide whether sufficient service can be obtained from the old winding to justify the expense of reconnecting, or whether the machine should be rewound.

When appraising the windings, the following points should be kept in mind: line voltage, operating conditions (exposure to dirt, moisture, steam, acid fumes, etc.) and the possibilities of dipping and baking the windings after reconnecting.

Dipping the reconnected winding in a good grade of baking varnish, will add materially to the useful life of the changed machine. The limits as to the size of stator that can be dipped and baked will, of course, be governed by the equipment available.

On large machines, or where equipment is limited, the windings can be sprayed with a good grade of air-drying varnish, care being taken to get the varnish into all parts of the winding.

Assuming that the winding has been found suitable for further use, the next point to consider is phase insulation.

The question of phase protection requires considerable attention and a good knowledge of the methods used by different motor manufacturers. It is one of the limiting factors that determines whether any existing two-phase winding can be reconnected for three-phase operation, regardless of the condition of the winding.

Fig. 2—Two-layer, open-slot, diamond-coil winding, showing the phase (two dark) coils at the beginning and ending of each pole-phase group.

The total number of groups in any two-layer (two-coil-per-slot) type of winding is equal to the number of poles times the number of phases. Thus, on a four-pole, two-phase motor there would be $4 \times 2 = 8$ groups, and on a four-pole, three-phase motor there would be $4 \times 3 = 12$ groups.

Or, we can say that a three-phase winding will have 1.5 times the number of pole-phase groups in a corresponding two-phase winding. In the above case the two-phase winding had eight groups; then the three-phase will have $1.5 \times 8 = 12$ groups.

From above it can be seen that when changing from two- to three-phase, the total number of groups is increased and, with a given number of coils, that the number of coils in series in any pole-phase group must be changed.

Consider a four-pole, two-phase winding with 48 slots and coils.

Then there would be eight groups, with 48 ÷ 8 = 6 coils in series in each group. For a four-pole, three-phase winding with 48 slots and coils, there would be twelve groups and four coils in series per group, which means that when reconnecting from two- to three-phase the coils will have to be regrouped. It is this factor that brings up the subject of phase insulation in this article.

On the basis of its application, phase insulation can be divided into two groups:

1. All machines in which the phase insulation is applied directly to the coil ends, and the winder is not called upon to insert any additional material while winding the machine.

2. Windings in which the workman applies the phase insulation to the coil ends while winding the machine.

Considering the first group, some manufacturers apply extra insulation to the ends of those coils that are at the beginning and ending of each pole-phase group, as shown in Fig. 1 and Fig. 2. Fig. 1 represents two pole-phase groups, each group consisting of three coils connected in series. The heavy, black-line coils indicate the phase coils and their location; note that between any two pole-phase groups as in Fig. 1, there are two phase coils.

Thus, in any two-layer winding when the beginning and ending of each group is a phase coil, there is double protection between phases.

On open-slot machines in which the coils are completely insulated before installing in the machine, the phase coils are insulated for 110 volts and up to and including 600 volts.

The ends of the coils are taped with one half-overlapping layer of 0.010-in. thick bias-cut, treated cloth tape. This tape seals the ends of the wrapper used on the slot sections and extends across the diamond ends of the coils from wrapper to wrapper. This is in addition to the cotton tape used to finish the coil. The remainder of the coils do not have the treated cloth tape, one layer of cotton tape being applied. These are termed "plain coils."

The phase coils are identified by the manufacturers by painting the front diamond point with red paint; or, it will be noted that the phase coils have longer leads than the plain coils.

On large machines the phase coils are divided into two groups: one group, which includes half the total number of phase coils, will have the starting or top lead long and the finishing or bottom lead short. The second group will have the starting lead short and the finishing lead long.

The remainder of the set, the plain coils, will have both leads short. The long leads are used for jumpers to connect pole-phase groups together.

Fig. 3—Two-layer, diamond-coil winding of the threaded-in type, showing one phase coil per group. There are five coils per group.

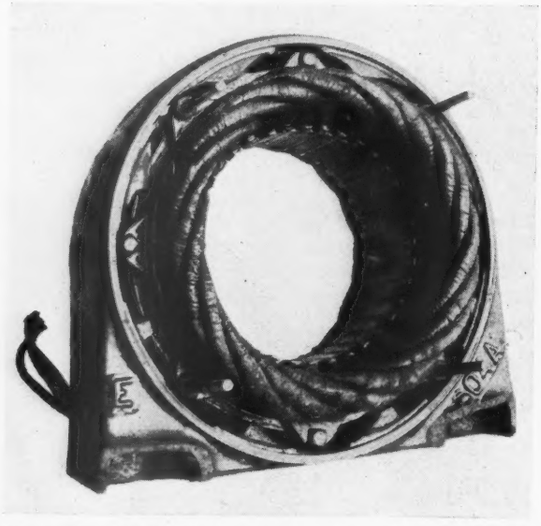


Fig. 4—In the basket type of one-coil-per-slot, threaded-in winding all of the coils are phase coils.

One other method of marking the phase coil is to tie a turn or two of tape or twine around the front diamond point, or pass a few turns of tape around the top or finishing lead where it leaves the coil. Above 600 volts and up to and including 2,400 volts the phase coils will have two layers of 0.010-in. bias-cut, treated cloth tape, and the plain coils one layer of 0.010-in. treated cloth tape.

There are some machines in the 1,100- and 2,400-volt class that have all the coils insulated alike with two layers of treated cloth tape. Some manufacturers use an extra layer of cotton tape as phase insulation.

On machines having a phase coil at the beginning and end of each pole-phase group (see Fig. 2), the total number of phase coils is always equal to twice the number of pole-phase groups.

The preceding indicates how the phase coils may be identified when the coils are received from the manufacturer, but after the machine is wound and the coils are in place, it is not quite so easy to determine the type of phase insulation used. Hence, some practical methods of determining the type of phase insulation will be helpful.

On open-slot machines up to 600 volts, inspect the coil ends, and if phase insulation has been applied to the coils these coil ends will be thicker than the others, and the thick coils will be located at the beginning and end of each group; or, there will be two thick coils together and then a number of thin coils. Depending upon the number of coils in series per group, this condition will indicate two phase coils per group.

The best way to start checking for phase-coil insulation is to locate the start and end of any one group, follow it through to the opposite side, and mark the two coils that start and finish the group. This procedure enables one to inspect the coil ends, without having the leads and jumpers in the way. By comparing the thickness of the coil ends it is a simple matter to determine whether there are one or two

phase coils per group, or whether all coils are insulated alike.

If all coils are of the same thickness and no other visible, additional insulating material is used, it is safe to assume that all are insulated as phase coils and that the winding can be regrouped for three-phase operation, if further checking shows that reconnection is possible.

We can now pass on to the second group of phase insulation which covers insulation applied to the coils during the process of winding the stator. This group covers a greater number of combinations, as in it are included open-slot windings, as well as the partly-closed-slot, threaded-in types of windings.

First, we have the two-layer, two-coil-per-slot, diamond-pulled coil type of winding, shown in Fig. 3, in which the coils are wound with gum-treated wire. The wires are kept in layers and the rear diamond points are tied with a waxed cord; the front diamond point is taped with 0.007-in. cotton tape and extends approximately 1 in. on the end of the coil. The leads are tied to the coil with waxed cord bands.

These coils are used on the Westinghouse Type CCL and HF stators and the HF and F rotors. When placing the coils in the machine, one coil at the end of each pole-phase group is taped with one layer of 0.010-in. bias-cut, treated cloth tape, half overlapped, and one layer of 0.007-in. cotton tape half overlapped. As will be seen in Fig. 3, the remainder of the coils are not taped.

In this type of winding there are as many phase coils as pole-phase groups, and they are located either at the beginning or the end of the group, according to the way the winder starts out.

When untreated wire is used in the above types of motors all the plain coils are taped with one layer of cotton tape, and one phase coil of each group is taped as explained before.

The latter method of insulating the coil ends of two-layer, threaded-in windings using layer-wound or mush-wound types of coils is the one most widely used.

Next, we have the one-coil-per-slot type of threaded-in winding, the most common being the basket type, shown in Fig. 4. The coils are wound mush from untreated wire and all coil ends are taped by the winder with one layer of 0.010-in. thick, bias-cut, treated cloth tape half overlapped, and one layer of 0.007-in. cotton tape, also half overlapped.

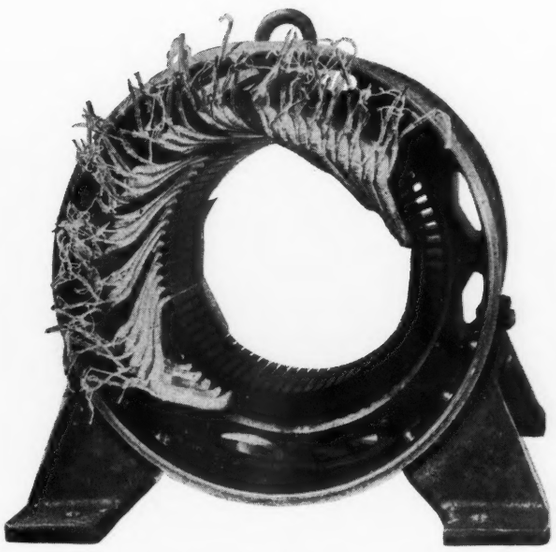


Fig. 5—A two-layer, diamond, mush-pulled-coil, threaded-in winding. All coil ends are taped and the phase insulation consists of two triangular pieces of treated cloth placed between the pole-phase groups.

In this type of winding there are one-half the number of coils as there are slots in the machine, and all the coils are phase coils. Thus, they can be regrouped for three-phase operation and still have correct phase insulation.

There are some one-coil-per-slot, two-layer, diamond-end windings, but the mechanical arrangement of the coils in each group governs the possibilities of regrouping for three-phase. In this type of winding the coil ends are insulated the same as in the basket type.

Next, we have the two-layer, threaded-in type, wound with mush coils of untreated wire, in which all coil ends are taped with one layer of 0.007-in. cotton tape, half overlapped. For phase insulation, triangular pieces of treated cloth (see Fig. 5) are placed between the coil ends, at the end of each pole-phase group.

On the smaller machines the coil ends are not taped, but triangular pieces of treated cloth are placed between all coil ends, and for phase insulation two pieces are used at the end of each pole-phase group.

On some makes of low-voltage, open-slot, two-layer windings the coils are all insulated alike; that is, no phase insulation is applied to the coils, but the winder places triangular pieces of treated cloth between pole-phase groups.

When it is desired to reconnect any winding from two-phase to three-phase, a careful check should be made to determine how the phase groups are insulated and whether the winding can be regrouped and the proper phase protection provided for the three-phase arrangement of coils. When regrouping any two-phase lap (two-layer) winding for three-phase, it is possible to arrange the three-phase grouping so that some of the two-phase insulation can be used. Some examples will be given in a succeeding article to show the possibilities of this procedure.

Montefiore Prize Award Announced

FOR the year 1929, the George Montefiore Prize has been awarded to R. D. Evans and C. F. Wagner, Westinghouse engineers, in conjunction with three other engineers: Algeri Marino, Rome, Italy; H. Parodi, and Pestarine, Paris, France.

This triennial prize presented by the Fondation George Montefiore, Liege, Belgium, for the best original work contributing to scientific advancement in the technical applications of electricity was given to Messrs. Evans and Wagner for their papers, "Studies of Transmission Stability," and "Static Stability Limits and the Intermediate Condenser Station." The amount awarded to Messrs. Evans and Wagner was 3,000 Belgian francs.

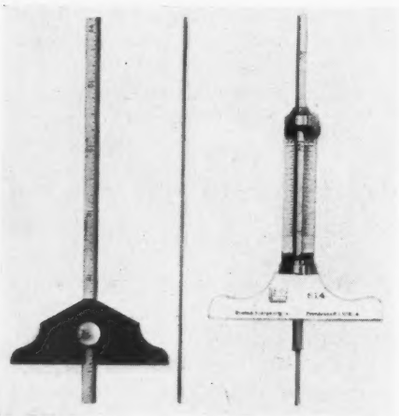
The Fondation George Montefiore was begun by the man whose name it bears, for the encouragement of scientific investigation and research in the technical applications of electricity. It is administered through the Assocation des Ingenieurs Electriciens, the national electrical engineering society of Belgium, with headquarters in Liege.

EQUIPMENT NEWS

Industrial plant executives concerned with the selection and operation of mechanical and electrical equipment will be interested in these devices which are designed to improve plant operation or reduce operating and maintenance costs.

Brown & Sharpe Nos. 614 and 617 Depth Gages

DEPTH gages, Nos. 614 and 617 have been introduced recently by the Brown & Sharpe Manufacturing Company, Providence, R. I. Graduated rod depth gage No. 614 measures the depth of large or small holes from 0 to 3 in. directly in 64ths. The wide base and slender rod make this tool convenient for use in measuring holes of either large or small diameter. The rod is graduated each inch for three inches. For the first 5/8 in. the rod is



1/16 in. in diameter and the remainder is 1/8 in. in diameter. A base 2 in. wide by 1/4 in. thick is used.

Drill point and depth gage No. 617 can be used for checking the angles of drill points when grinding them, and to determine whether the point is central. It may also be used as a gage for finding the depth of holes as small as 3/32 in. in diameter. The graduated bevels on the head are ground to an included angle of 59 deg. The 6-in. rule is graduated in 32nds and 64ths and a 6-in. rod 5/64 in. in diameter is furnished for use in measuring the depth of small holes. The No. 617 has a range of 0 to 5 in. It may also be furnished to measure in metric units if desired.

Oxweld No. 22 S. D. Steel Welding Rod

OXWELD ACETYLENE COMPANY, 30 East 42nd St., New York City, has placed on the market a welding rod, designated Oxweld No. 22 S. D. (strength and ductility) steel welding rod, for making extremely strong welds in steel. This welding rod has been developed especially for use in making joints in steel pipe having a carbon content of 0.30 to 0.40 per cent. In general appearance, weldability, chemical and physical properties, No. 22 S. D. rod is similar to the No. 1 high-test rod, but it will produce welds of even higher tensile strength, it is stated.

This welding rod is available in 3/16-, and 1/4-in. diameters in 36-in. lengths. It is a self-fluxing and deoxidizing rod which sparks very little. It forms a fusible slag that rises to the surface where it serves as a protective coating which, although extremely thin, protects the surface of the molten bath from the oxygen of the air and thus prevents oxidation. The composition of this rod also prevents the strengthening element, carbon, from burning out during the welding operation. It has the ability to fuse easily into the base metal at both the sides and the bottom of the vee.

St. Paul Welding "Torit" Type 8-K Kerosene Burner

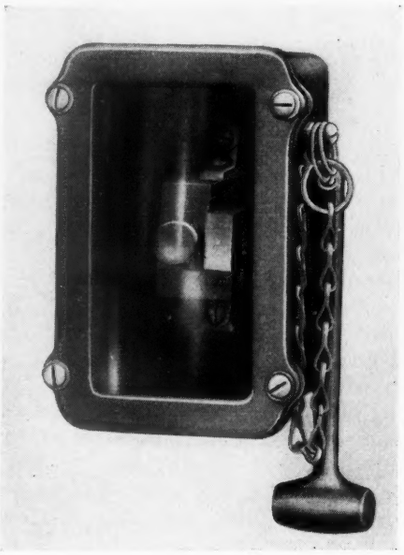
FOR preheating heavy pieces of iron and steel before welding, the "Torit" Type 8-K kerosene burner has been placed on the market by the St. Paul Welding & Manufacturing Company, 174 West Third Street, St. Paul, Minnesota.

The burner is a portable hand pump outfit which throws a flame about 2 ft. long. The tank is of 10-gal. capacity and is equipped with a double-acting pump allowing for suction of either air or kerosene.

This arrangement permits the tank to be refilled while the torch continues to operate.

General Electric Emergency Stop Switch

AN emergency stop switch, designated SY-109-B, for application in plants using ammonia compressors for refrigeration, has been announced by the General Electric Company, Schenectady, N. Y. The switch is especially designed for use where it is required that such installations be equipped with an emergency device externally located, for shutting down the compressor motor in emergency.



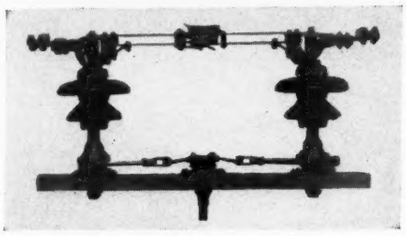
The switch has a glass cover and is provided with a small hammer on a chain. Inside is one set of switch contacts in a closed position. Starting and stopping are done by means of a magnetic switch. The contacts of the emergency switch are wired in series with the "stop" button of the magnetic control.

Breaking the glass of the emergency switch allows the normally closed contacts to open and thus stop the motor. An additional set of contacts closes when the glass is broken. The advantage of closing one circuit while the other is opened is the possibility thus afforded of lighting or sounding a warning signal at some remote point such as the fire station whence apparatus could be sent to the scene of the trouble.

The inclosing case is finished in bright red, indicating that it is an emergency device.

Delta-Star Disconnecting Switch

A SIDE-OPENING, gang-operated, disconnecting switch, with both insulators rotating, has been developed by the Delta-Star Electric Company, 2400 Block Fulton St., Chicago, Ill.



The double blades are provided with full-floating contacts incased in a sleet-proof housing.

Terminal lugs are of the solderless compression type. These switches are made for voltages up to 132 kv. The single-pole element illustrated is rated at 37 kv., 600 amperes.

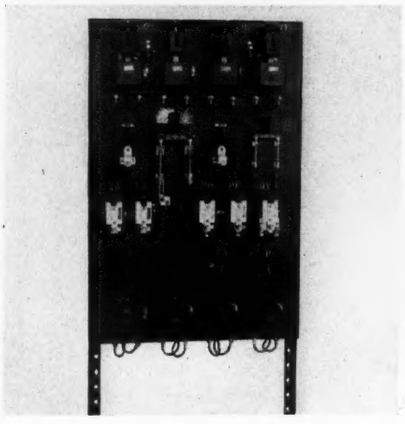
General Electric Panels for Steel Mills

IN the redesign of magnetic controllers for steel mill auxiliaries, bearing the designation CR-4261, announced by the General Electric Company, Schenectady, N. Y., a separate line contactor is used instead of a "circuit-breaker" contactor to allow complete isolation of the motor and starting resistor from the source of power.

According to the announcement other improvements include: "An additional relay for undervoltage protection. In the case of the smaller panels, up to 55 hp., all devices are mounted on a single compound base. Three compound bases are used for the larger units.

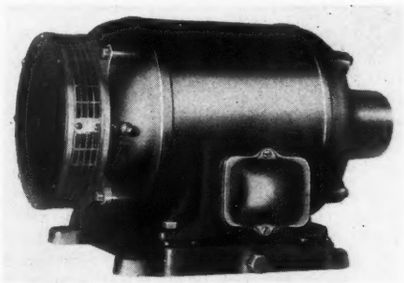
"An overload relay that is not affected by vibration, and which employs but one size of coil for the entire range of horsepower of any given panel, is also used. A large number of the parts of the overload relay are interchangeable with those of the accelerating relays.

"Master switches have also been developed for use with the panels to allow single-or three-point operation of the line contactor. Each switch includes double-break, silver-faced contacts carried on molded operating arms actuated by molded cams bolted to the shaft. The handle of the switch is fitted with a grip and may be locked in the "off" position. The redesigned line is also equipped with an improved type of edgewise-wound resistor."



Century Totally-Inclosed Motor

FULL protection of the stator, rotor, and other internal parts of the unit, all of which are completely isolated from outside air, characterize the totally-inclosed, fan-cooled, squirrel-cage induction motor introduced by the Century Electric Company, 1806 Pine St., St. Louis, Mo. The fan and fan housing are externally mounted on the front end of the motor opposite the pulley end. The cooling air is drawn in at the pulley end, circulated around and over the rear coil guard, through the air passages between the field core and the frame, out over the coil guard on the front end, and discharged into the air through the fan and the fan housing.

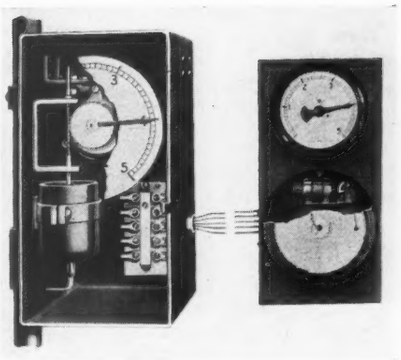


Provisions are made to circulate the air within the motor shell and transfer the heat to the radiating surfaces where it is carried away and dissipated by the cooling air.

Bailey Selsyn-Operated Devices

A COMPLETE line of Selsyn-operated instruments for remote indication and recording of liquid level, pressure, temperature and other factors is now being marketed by the Bailey Meter Company, Cleveland, Ohio.

Three types of transmitters are used for remote indication of liquid level. In one a large hollow float rests on the surface of the liquid whose level is to be measured or indicated, and is connected by a counter-weighted cable and gear train to the generator. A second type of transmitter employs a steel float resting on the surface of mercury in the open leg of a mercury U-tube so arranged that the generator rotor is driven through a rack and pinion. The actual pressure due to the height of liquid in the tank or reservoir is the actuating medium. For indicating levels in closed tanks or drums under pressure, a transmitter in which the actuating mechanism is a straight-walled inverted mercury-sealed bell, is used.



For long distance transmission of pressure readings two types of transmitters are available. One consists of a mercury U-tube with the closed leg of the tube connected to the source of pressure, while the other leg terminates in an open reservoir in which a steel float rides on the surface of the mercury.

For pressures above 50 lb., the transmitter consists of an expansive metallic bellows or sylphon connected to the generator rotor by a gear sector and a pinion. When used for pressure, the lower end of the sylphon is connected to the source of pressure.

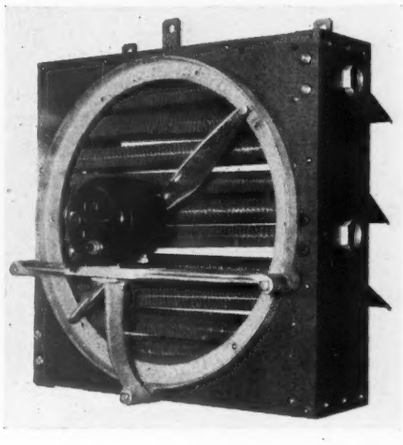
Transmitters to indicate and record vacuum, temperature, and drafts, are essentially modifications of those already described.

A standard indicator and recorder for use with the transmitter is shown at the right in the illustration. Several types and sizes of these indicators are available to meet individual needs.

Wolverine Unit Heater

A UNIT heater with coils of seamless copper tubing in single pieces running from the inlets to the outlets, and known as the Wolverine unit heater, has been introduced by the Wolverine Tube Company, 1411 Central Ave., Detroit, Mich. This heater is supplied with the Hartzell fan. Other makes of fans are optional.

Knees or bends in each tube are hung in stirrups avoiding the danger of wear when the tubing expands or contracts. The copper fins are of one continuous strip and are attached permanently to

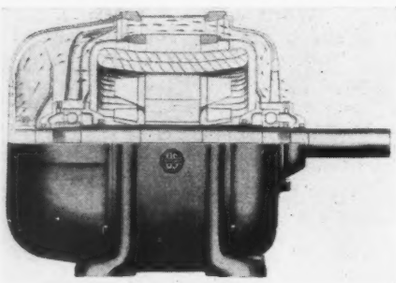


the tubing so that maximum contact and strength are maintained. Tubing size is designed in the proper relation to the volume of inlet and outlet and the number of inlets and outlets are so proportioned that condensation cannot interfere with distribution. The coils are tilted slightly from the horizontal making drainage complete under all conditions.

Louvers are individually adjustable. The frame is made of rust-proof pressed steel, and is fitted with three suspension brackets. The complete unit is tested to 1,000 lb. hydraulic pressure. The complete fan assembly, except the motor, is made of a rust-proof and acid-resisting aluminum alloy.

United States "Doublenclosed" Motor

SEVERAL improvements are incorporated in the latest model, the "Doublenclosed" motor, manufactured by the United States Electrical Manufacturing Company, Los Angeles, Calif. Asbestos protection is employed where-



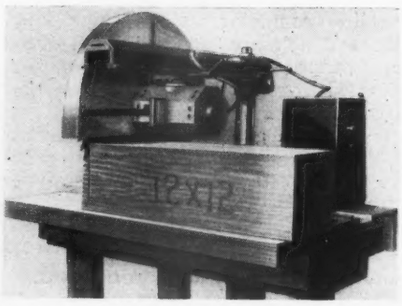
in the wires are insulated in conjunction with a heat-resisting compound known as Asbestosite.

The motor is incased within a sealed metal housing, outside of which is a chamber that is air-blasted by positive fan action. Deteriorating elements are expelled from the outer chamber, making it impossible for foreign matter to enter the chamber in which the moving parts are housed. This unit is especially applicable for industries where dangerous fumes, moisture, dripping water, abrasive particles, dripping acids, and alkalis are prevalent.

DeWalt Heavy-Duty Timber Cutter

FOR shops using heavy timbers for shoring purposes, and the shipment of heavy machinery, the heavy-duty cutting equipment illustrated, has been developed and placed on the market by the DeWalt Products Corporation, Leola, Lancaster County, Pa. Heavy timbers can be handled with ease by one man feeding the saw through the material by means of a hand ratchet gear feed or by chain feed on the arm of the machine. This arm may be raised or lowered to the depth of the cut.

Saw blades up to 36 in. are provided to handle 12x20-in. material, or a 16-in.



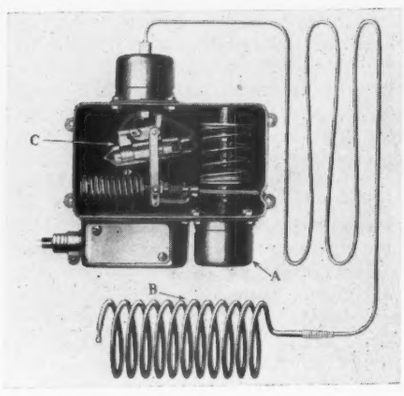
dado head may be used to dado to 3 in. The saw blade operates at 1,750 r.p.m. and is driven direct by a motor operating on either two- or three-phase, 220- or 550-volt circuits.

Two sizes are supplied: Model L with a capacity of 12x12 in., and Model T with a capacity of 12x20 in. Model T is mounted on an all-metal table equipped with steel conveyor rollers for easy handling of heavy material. The elevating device is operated by a wheel in front of the table.

American Dual Control for Unit Heaters

MODEL DMS mercoid control for unit heaters, put out by the American Radiator Company, 40 West 40th St., New York, N. Y., combines two instruments in one: automatic control of room temperature by starting and stopping the fan motor according to changes in air temperature, and an automatic cut-off which stops the motor, or prevents it from starting, in case the heating surface of the unit is cold.

Two thermostatic elements are used, each operating the same mercoid switch. The lower element A is actuated by the temperature of the air, which is drawn over it by the fan. With an increase in air temperature the element A tilts the switch C and opens the motor circuit. A decrease in temperature causes the motor to start. The upper element is equipped with a flexible thermostatic tube, four feet of which is wound around the condensation or drip line. As long as this pipe is cool, the element B locks the switch C in position with the circuit broken and any change in air temperature cannot start the motor.

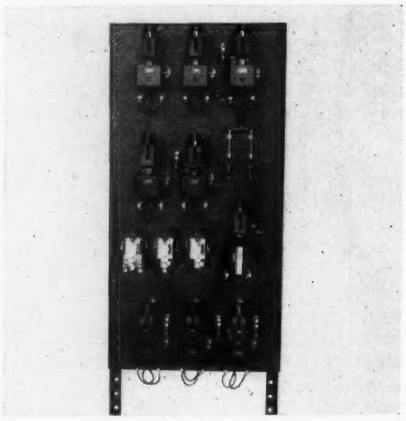


When steam fills the heating surface and the drip pipe warms to 160 deg. the upper element expands and releases the lock, allowing the lower element A to start and stop the motor to maintain the desired temperature. If it is desired to operate the fan in summer a hand switch may be inserted across the control circuit of the fan motor.

General Electric Crane and Hoist Control

A REDESIGNED line of magnetic control panels for use with cranes, has been announced by the General Electric Company, Schenectady, New York. Two types of control are involved; one, designated CR-4426, is for use on the bridge and trolley motions of cranes, and the other, designated CR-4422, is for use on hoist motors.

Each type of control is available in two forms, one with and one without overload protection. On both of these forms, the circuit breaker contactor which opened only on overload, has been replaced by a line contactor. This is placed on the opposite side of the

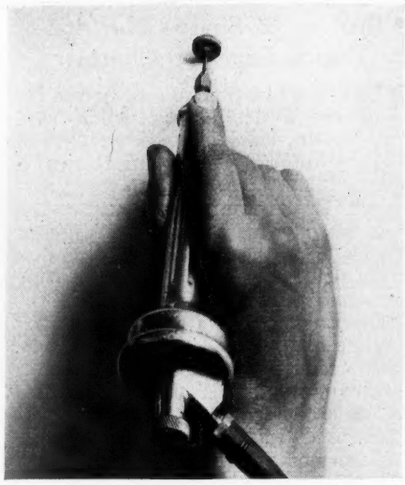


line to the reversing contactors and opens each time the master switch is returned to the "off" position. This allows complete isolation of the motor and starting resistor from the sources of power when the master switch is moved to the "off" position. A three-point, cam-operated master switch is used with the controller.

Overload relays are also incorporated, allowing a greater calibration range and permitting the use of but one coil instead of two or three for a given contactor size. This unit is available either with or without shunts.

Madison-Kipp Air Grinder

NOW available is an air grinder marketed by the Madison-Kipp Corporation of Madison, Wisconsin. It is unusual because of its size and high rotative speed. The overall length is 8¼ in. and the barrel diameter is slightly under 1 in., the weight being 12 ounces. Compressed air at ordinary shop pressures is used for its operation. Spindle speed is 40,000 r.p.m. In



operation the grinder is held in the hand and is used somewhat as a fountain pen is used.

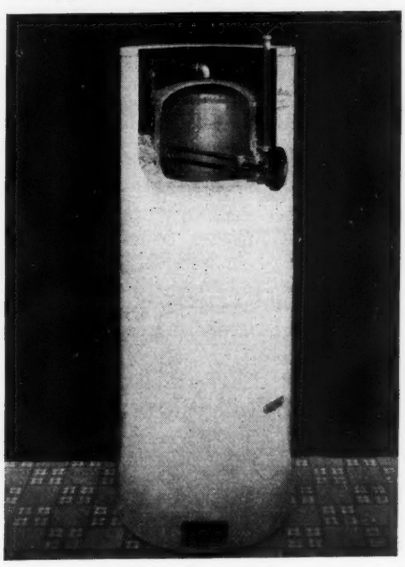
The upper bearing is a grease-seal ball bearing, and the lower bearing is made of special bronze. Both bearings are provided with lubrication devices. The exhaust air acts to keep the bearings cool.

Westinghouse Adapt-O-Matic Water Heater

ITS name, "Adapt-o-matic," best describes the storage-type electric water heater recently placed on the market by the Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa. It is suitable for either full or semi off-peak heating and for continuous or intermittent service.

With both elements of the dual-element heater in multiple, maximum wattage is delivered. If one unit is connected with the line, half wattage is obtained. Quarter wattage results from series connections. When one heater is connected through a timing device to a semi off-peak meter, advantage may be taken of the lower power rate available for this type of load.

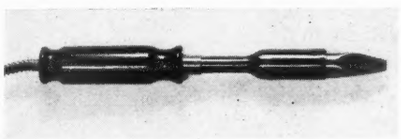
A Spencer thermostat and the Corox heating element give this heater automatic control. When hot water is drawn from the heater the incoming cold water at the bottom of the tank causes the thermostat in the lower heating element to close the circuit. The upper heating element is not affected, however, unless a sufficiently large draw-off has been made to materially lower the temperature of the water at the top of the tank.



The Adapt-o-matic heater is furnished with either galvanized or copper tanks of 30- or 52-gal. capacity. A thickness of 4 in. of Balsam wood on the 52-gal., and 3 in. on the 30-gal. heater incloses the tank which is mounted on wooden blocks.

Electric Soldering Irons

SOLDERING irons designed for constant duty have been introduced by the Electric Soldering Iron Company, Inc., 135 West 17th St., New York, N. Y. The tools are stocked in all



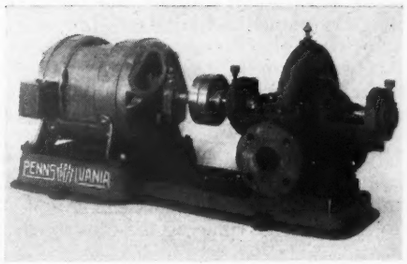
standard voltages and in capacities from 65 to 500 watts.

They are made in 8 sizes ranging from Type 55 for light work, to Type 500 for very heavy soldering such as large tanks, roofs and objects of large area. The tool consists of blue steel, one-piece case, mahogany anti-heat handle, forged copper tip, and grade A nickel chrome element, wound on mica insulation. The length of the smallest tool, Type 55, is 10½ in.; Type 500, 14½ inches.

Pennsylvania Centrifugal Pump

BALL-BEARING, double-action, single-stage centrifugal pumps, designated BMD and BHD, have been introduced by the Pennsylvania Pump and Compressor Company, Easton, Pa. These units are suitable for capacities up to 1,800 g.p.m. against heads up to 300 ft. Casings are made of close-grained iron, horizontally split, with suction and discharge openings cast in the lower half. Bearing brackets to support ball bearing housings are cast integral with the pump. Provision has been made in the casing and brackets for drain taps. The upper half of the casing has outside sealing pipes leading from the pump to the packing boxes, with air cock at the top.

A double-suction, inclosed-type bronze impeller is attached to the shaft by a shoulder and jam nut and locked with a Woodruff key. Deep-groove ball bearings, mounted in sealed housings, carry the shaft, which is of special alloy stainless steel, heat treated and ground over its entire length, including the taper for mounting flexible couplings.



It is direct connected to the prime mover by means of a flexible-pin and rubber-buffer coupling. The complete unit is mounted on a cast-iron base plate with a drip canal around the pump end.

General Electric Colored Code Wires

A COMPLETE line of colored code wires which permit positive identification of all circuits and insure convenience in testing has been announced by the Bridgeport, Conn., Merchandise Department, General Electric Company. Eight colors are furnished: black, red, green, white, blue, yellow, brown, and white with tracer.

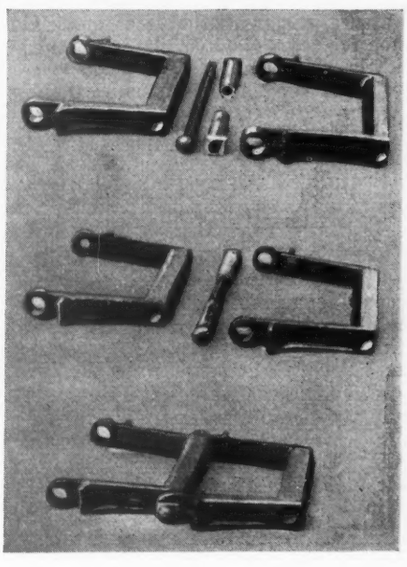
Through the use of colored wires in buildings, alterations and additions to the wiring can be more readily made, as the necessity for tracing circuits and testing lines is entirely eliminated.

These colored code wires form an integral part of the General Electric wiring system and are available in No. 14 solid single braid in Code, Intermediate, and 30-per cent grades.

American Conveyor Chain

A CONVEYOR or drag chain for handling refuse or any other like material has been developed by the American Manganese Steel Company, Chicago Heights, Ill. The links are made from manganese steel.

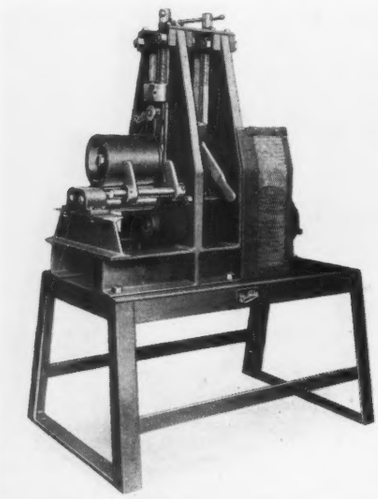
Instead of the usual steel pin or rivet running clear through the body of the link, each link is supplied with two



manganese steel bushings, one for each eye of the link. These are held in place by a steel pin passing through them in the link barrel. This bushing arrangement enlarges the bearing surface and does away with the bowing and distorting common to the regular steel pins (with its consequent elongating of the chain pitch) and the trouble in removing or replacing the pins when worn.

Buffalo Wrapping Rolls

WRAPPING rolls for forming metal cylinders from 5 to 30 in. in diameter, from 2½ to 20 in. in depth, from metals ranging in thickness from 1/16 to 1 in., have been announced by the Buffalo Forge Company, Buffalo, New York, N. Y.



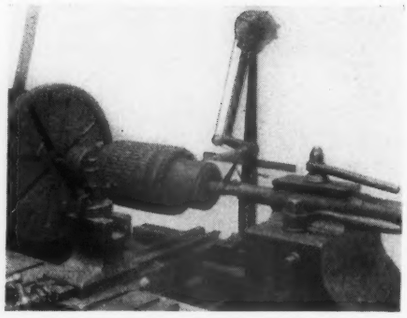
Special flanged shapes with special rolls may also be produced.

Each cylinder diameter requires a separate master roll; aside from this all changes are made by means of the twin-screw adjustment at the top of the machine. The quick acting release makes it possible to remove completed cylinders without disturbing the setting of the rolls. Guide fingers are used to assure proper alignment of material when feeding. The machine is equipped with bronze bushings, Alemite lubrication, and a guaranteed, unbreakable "Armor-plate" frame.

Hullhorst Lathe Type No. 9 Undercutting Machine

DESIGNED for use on lathes of from 14- to 24-in., swing the undercutting machine, designated No. 9, recently brought out by The Hullhorst Micro Tool Company, 3242-D Monroe St., Toledo, Ohio, enables the operator to complete the three operations of truing, undercutting, and polishing before removing the armature from the lathe.

It undercuts all armatures up to 22 in. in diameter, and its design provides sufficient flexibility to make accurate guiding easy. Uniform depth of cut is



assured by a depth-gage bar which is regulated for fine adjusting with a thumb screw.

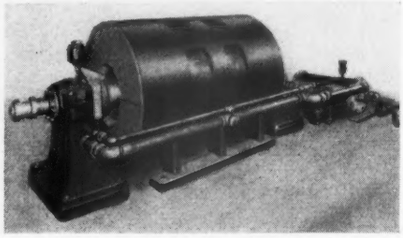
A slotted angle plate is used to attach it to the lathe carriage. The lower, or spindle arm, swings to left and right, and when pushed up remains out of range of lathe work. Power is transmitted through a single belt from motor specified. The spindle, quill, cutter arbor, and pulley constitute a self-contained unit. The complete unit weighs 34 lb., and includes 20¼-in. diameter cutters varying from 0.015 to 0.035 in. in thickness.

Westinghouse 3,600 R.P.M. Induction Motors

WESTINGHOUSE Electric & Manufacturing Company, E. Pittsburgh, Pa., has developed a line of 3,600 r.p.m. induction motors. Motors with ratings of 500 hp. up through 1,250 hp. are now in service. According to the manufacturer, these motors have high efficiency and power factor, even at light loads, and the starting currents are low. They require little space; the largest one built to date weighs only 7,700 pounds.

One-piece punchings of silicon steel are used in both stator and rotor, and the primary slots are of open type, facilitating the removal and replacement of coils. The primary coils are completely formed and insulated before being placed in the slots. The coils are tightly wedged in the slots and the end turns are braced to permit starting without injury on full voltage.

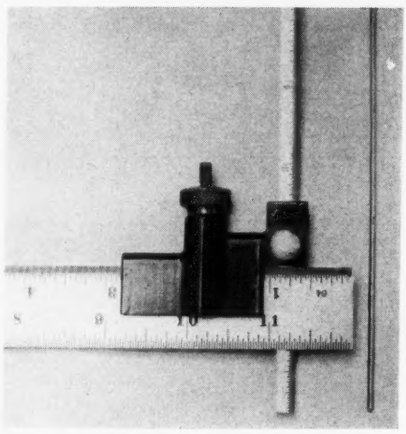
The rotors are all dynamically balanced and tests show them to run smoothly at 4,500 r.p.m. Bearings are of the pedestal type, split at the horizontal center line, making possible removal of the bearings without dismantling the motor. They are lubricated by oil, under pressure, supplied by a positive feed pump which is driven from the motor shaft through gears. Labyrinth seals and felt washers protect them from dust and dirt.



Browne & Sharpe No. 468 Depth Gage Attachment

THE combination square or set becomes a depth gage when used with the No. 468 depth gage attachment recently announced by the Brown & Sharpe Manufacturing Company, Providence, R. I. This attachment measures directly from the lower edge of the blade of the square or set and is easily read. It is useful for measuring the depth of wide recesses.

The English measure attachment has a range of 0 in. to 4½ in. with a 6-in. blade graduated in 32nds and 64ths, or 64ths and 100ths. A blade graduated in 32nds and 64ths is furnished unless otherwise specified. A metric measure attachment has a range from 0 to 114 mm. A rod, 5/64 in. in diameter, is



furnished for use in small holes. No. 468 may be used on 9-in. 12-in., 18-in., and 24-in. Brown & Sharpe combination squares and sets with heavy blades.

General Electric Expansion Bends

EXPANSION bends for connecting rigid conductors to transformer and oil circuit-breaker studs are announced by the General Electric Company, Schenectady, N. Y. The bends are made from rectangular copper bar.

These devices protect the bushings from strains which result from thermal expansion of conductors and uneven settling of the transformer and oil circuit-breaker foundations with relation to the structure. They are applicable to copper bar and copper tubing. In the latter application, however, it is necessary to flatten the tubing at the point where the unit is attached.

Although units are supplied with the necessary galvanized hardware Everdur hardware will be supplied upon request.

Baldor Ball-Bearing Motors

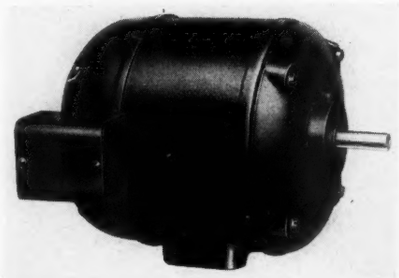
A LINE of matched-frame, ball-bearing motors, comprising single-phase, polyphase, d.c., and condenser types, and designed especially for use on fans and blowers, has been developed by the Baldor Electric Com-

pany, 4351 Duncan Ave., St. Louis, Mo. The line can be supplied with bases for flat mounting or with a round stator for ring mounting.

Mounting dimensions and the whole assembly, with the exception of the punchings and the windings, are identical for all motors of a given rating and speed. The stator construction completely houses the punchings and the end plates are uniform and can be used on all types of windings.

For applications where air is not drawn over the motor open end-plate construction may be used. Where air is drawn over the motor the totally-inclosed type is furnished.

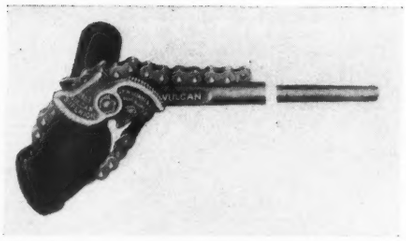
All motors are equipped with ball bearings. Leads are brought out through the end plates so that a conduit



box or flexible conduit can be easily attached. Either the box or the fitting is furnished as standard equipment. The position of these may be varied from top to bottom or to either side of the motor.

Williams Chain Tongs

REVERSIBLE jaws with a toothed recess making the wrench as readily adjustable to fittings as to pipe is a feature of the wrench, designated "Vulcan Superior," introduced by J. H. Williams & Company, Buffalo, N. Y. The parallel curved jaws are for use on pipe, while the toothed recess between

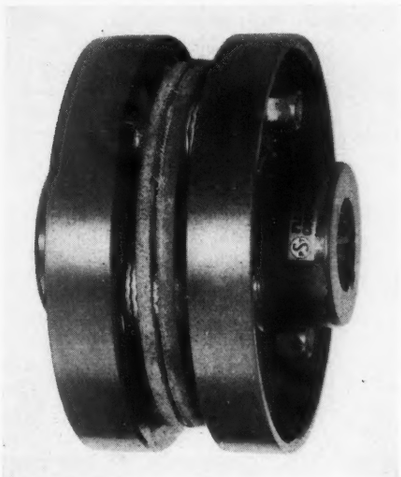


the jaws assures positive grip on fittings.

Tongs equipped with either cable or flat chains, which handle pipe from ⅛ to 12 in. in diameter, are available in a number of sizes. The change from the teeth first in use to a new jaw is made by unscrewing the bolt and turning the jaw end for end.

Smith Flexoid Shaft Couplings

COUPLINGS in which the ends of the shafts are permanently bolted to disks of flexible fabric so that there are no metal-to-metal bearing surfaces, are now being marketed by the Smith

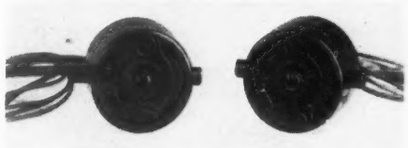


Power Transmission Company, 1213 West 3rd St., Cleveland, Ohio.

The fabric is so treated that it is impervious to the action of oil or water. The coupling acts as a cushion absorbing all vibrations, shocks, and jolts which would be injurious to the driving unit. It can be used in either a horizontal or a vertical position.

Westinghouse Control Switch

A THREE-PISTON, single-pole, double-throw control switch intended for use with a magnetic starter controlled by an automatic master switch such as a thermostat, pressure switch, or float switch, is manufactured

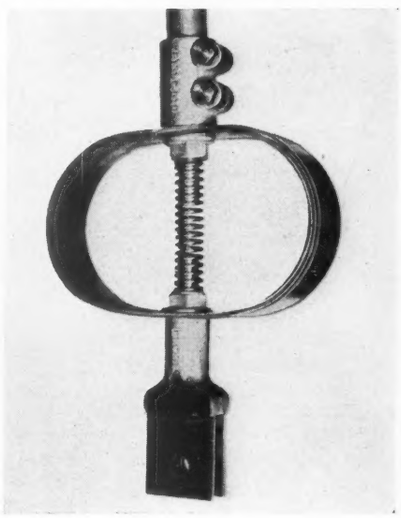


by the Westinghouse Electric & Manufacturing Company, E. Pittsburgh, Pa. The center position is the "off" position; the motor runs when the switch is in the "hand" position; and, when the switch is in the "automatic" position, the motor is started and stopped by the automatic master switch.

Base and the cover of the switch are made of a hot-molded insulating compound. Contacts are operated by a lug on a molded push rod. The switch is designed for mounting in any ¾-in. conduit knockout. A lock nut is furnished for holding the button in place.

Delta-Star Combination Support and Expansion Joint

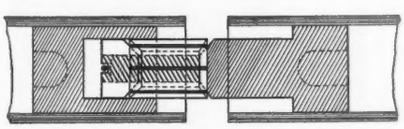
A COMBINATION support and expansion joint to protect bushings of oil circuit breakers, transformers, etc., used in sub-stations against thermal expansion of their conductors due to unequal settling of structure footings, has been introduced by the Delta-Star Electric Company, 2400 Block, Fulton St., Chicago, Illinois.



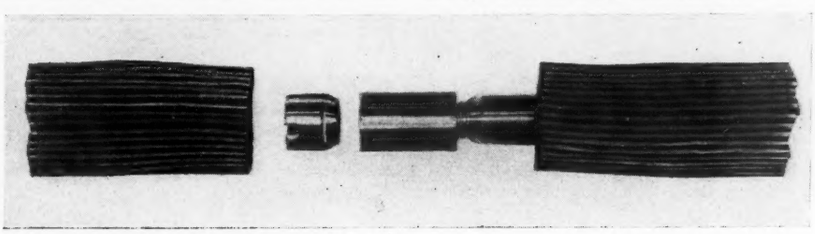
Modern Machine Power Plug Connector

A POWER-PLUG connector which locks in position with a slight turn of the wrist has been placed on the market by the Modern Machine Shop, Inc., Danville, Ill. Details of the connector are shown in accompanying illustrations.

Brass is used in its construction; the essential parts consisting of a male and female coupler with an internal expanding sleeve actuated by a locking pin and expanding nut. The female coupler has a riveted pin which engages the slotted nut when the connection is made. A slight twist of the two conductor ends causes the nut to tighten on the internal expanding sleeve thereby locking the connector in position. To break the connection a twist is made in the opposite direction.



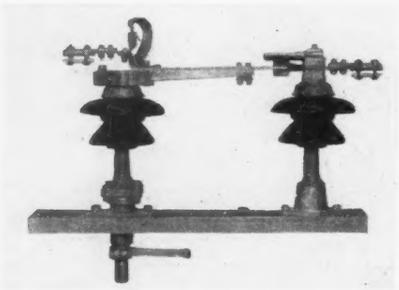
Rubber hose is used as an insulator over the connector ends to safeguard the operator making the connection.



The joint carries the weight on a spring, the stiffness of which can be regulated to the amount of the load carried. Alignment is maintained by two studs extending part way through the spring and by the current-carrying laminations themselves which deflect along a path parallel to the conductor.

Delta-Star Gang-Operated Disconnecting Switch

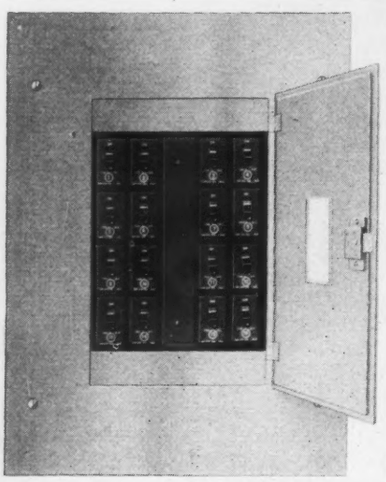
POLE-TOP gang-operated disconnecting switches, which may be either hand or motor operated, have been developed by the Delta-Star Electric Company, 2400 Block Fulton St., Chicago, Ill. Solderless compression-type terminal lugs are used.



The switches are made for a variety of ampere and voltage ratings. The single pole element illustrated is rated 15 kv., 6 amperes.

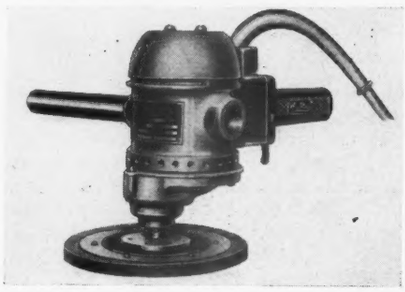
Trumbull No-Fuse Panel Board

PANEL boards equipped with G. E. automatic circuit breakers, combining the positive action of the magnet with the time lag of the thermal element, have been introduced by the Trumbull Electric Manufacturing Company, Plainville, Conn. The breaker on an overload clearly indicates "off." The tumbler handle can be moved immediately to the "on" position and the connection re-made without waiting for the element to cool. Bakelite covers which prevent the entry of dirt or any foreign substance inside the mechanism are used on each breaker.



Van Dorn 7-In. "Flex-Disc" Grinder

A 7-IN. "Flex-Disc" grinder has been added to the line manufactured by the Van Dorn Electric Tool Company, Cleveland, Ohio.



This machine is a companion unit for the 9-in. grinder, and is suitable for smoothing metal surfaces before painting; smoothing welded and soldered joints and seams; cleaning dies, and any other work requiring filing, sanding, and emerying. A felt-backed abrasive disk is used for performing the foregoing operation.

Improvements on the 7-in. grinder, which have also been applied to the 9-in. unit, are a removable pipe handle, and right- and left-hand bosses, making it possible to quickly and easily change from right- to left-hand operation or vice versa.

Pulvis Clutch

PERMITTING the motor or other prime mover to which it is connected to come to speed without load and then gradually accelerate the driven machine are features of the clutch put out by A. B. Pulvis, Stockholm, Sweden, and now being introduced in this country by Captain Nils

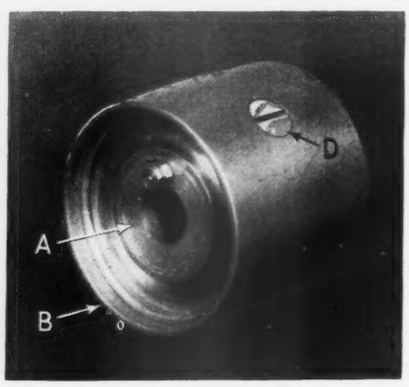


Fig. 1—Clutch assembly.

Wallenius, 114 East 52nd St., New York City.

Referring to Figs. 1 and 2, which show a pulley-type clutch assembled and unassembled, the winged hub or wheel *A* is fitted to the shaft of a motor or other prime mover and the cylindrical housing *B* is connected directly to the shaft of the machine or by means of a belt or other form of transmission.

It will be seen from a study of Fig. 2, the interior of the cylindrical housing or outer member *B* is corrugated, and the winged hub *A* is free to revolve within it, there being no definite connection between the two.

Power is transmitted between the two members by a steel powder which partially fills the annular space between them. In operation the powder forms in drifts ahead of the wings, as shown in the schematic illustration, Fig. 3, and by centrifugal force the density of the powder drift is increased to a point where the friction on the corrugated surface of the housing is sufficient to hold the two members stationary in relation to one another. When this point is reached they run at the same speed as long as the power required to drive

Fig. 2—View of clutch dismantled.

the load is less than or equal to the power which a given quantity of powder is capable of transmitting from the wings of the hub *A* to the housing *B*.

If the load on the driven machine increases above the point for which the coupling is designed the machine simply slows down, while the motor continues to run at approximately normal speed. As soon as the load is reduced to normal the machine is again accelerated to the speed of the motor.

The powder may be of various kinds, and by changing its qualities practically any accelerating characteristics can be obtained.

To permit uniform distribution of the powder between the wings of the hub *A*, the wings are provided with openings *C*. Powder is poured in or

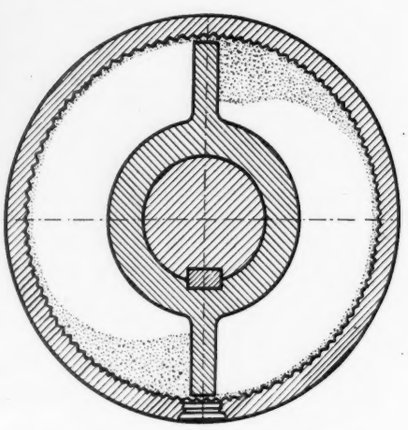


Fig. 3—Schematic diagram showing how powder forms in front of wings.

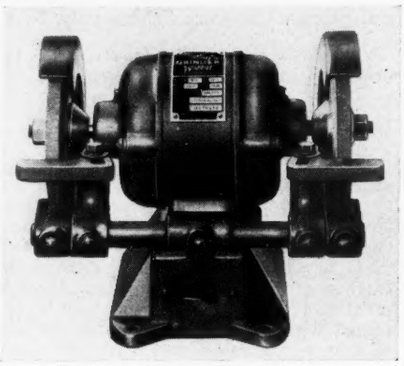
drawn off through the opening *D*, which is closed with a screw plug.

In addition to the pulley type illustrated, the clutch is made for a straight-through drive on direct-connected units and in other designs to meet practically any kind of service; one being where the wings are hinged to make them automatically collapsible inward into an inactive position.

In the model shown the housing *B* is provided with covers *E*. On the inner side of each there is a labyrinth seal which faces the felt rings *F* in the hub *A*. The center openings of the covers are bronze-lined and form bearings for the finished ends of the winged hub. The covers are held in place by expanding steel rings.

Wappat Red Streak Grinder

WAPPAT, INC., division of Simonds Saw and Steel Company, 7522 Meade St., Pittsburgh, Pa., announces its Red Streak portable, electric, bench grinder, which was designed for general grinding purposes, and tool sharpening.

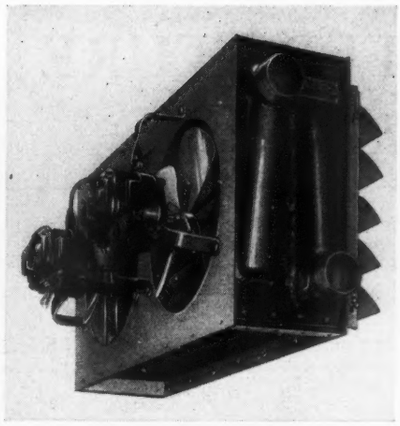


Although it is light enough to move from place to place conveniently, it is of sturdy construction. The two 6-in. grinding wheels are covered with adjustable safety guards, thus protecting the operator, and making it possible to grind at any position on the circumference of the wheels. The switch is located at the base to facilitate its operation. The rubber-covered cable is heavy enough to eliminate any chance of breaking from constant use.

United States Radiator Unit Heater

BUILT in the single- and duplex-fan types, the unit heater recently introduced by the United States Radiator Corporation, Detroit, Mich., is made in five sizes, with a selection of three constant speeds per size; 1,750, 1,150 or 870 r.p.m. Multi-speed motors are also available in each size to give quieter operating speeds with a high-speed reserved for the warming-up period.

These heaters are made entirely of copper and steel. All copper tubing that forms the heating element is fusewelded to the ⅜-in. steel header. The



sheet-steel casing is assembled and attached to the header by spot-welding.

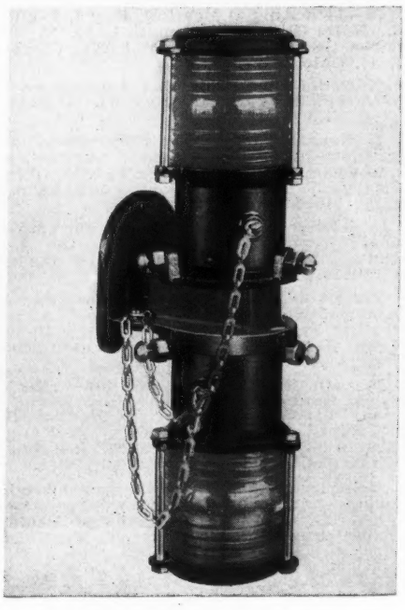
For hand operation, a self-contained, totally-inclosed, manually-operated switch with overload and under-voltage protection is furnished. For automatic operation a totally-inclosed, externally-operated, across-the-line switch of the quick-break safety type with thermal overload cut-out, is used in connection with a standard mercoid thermostat.

All heaters are adaptable for use with any electric current, floor recirculating boxes, or horizontal outside air intake boxes with recirculating dampers.

Nichols-Lintern Crane Lantern Signal System

TO safeguard the operation of more than one crane on a runway the Nichols-Lintern Company, 7960 Lorain Ave., Cleveland, Ohio, has placed on the market a signal system which consists of the Double No. 80 lantern (red and green fresnel), and a special switch.

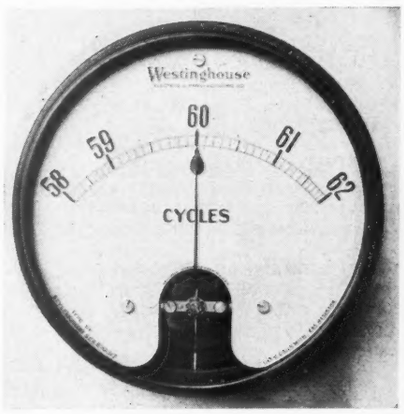
This switch has no neutral position; the lamp showing either a red or green signal at all times. No light is construed as a red light until investigated. The green light indicates that a crane may be moved without warning. The switch can be locked in the off (red light) position to assure workmen on the crane that the warning signal cannot be changed.



Two types of assemblies are available. Both are constructed to facilitate lamp changes, and are equipped with safety chains to prevent breaking of lens and other parts when changing lamps. The lamp unit has an over all height of 14⅝ in. and weighs 12 pounds.

Westinghouse Indicating Frequency Meter

A FREQUENCY meter of the indicating type having a scale range of plus or minus 2 cycles for 60-cycle work, has been developed by the Westinghouse Electric and Manufacturing Company, Newark, N. J. This instrument differs from the usual resonance type of ratio instruments in that a single resonant circuit of the parallel



type is employed, which results in a very low volt-ampere burden. The circuit design is such that the change of resistance of the reactors and coils due to temperature variations produces no effect whatever. The indication depends only on the values of inductive and capacitative reactance.

For use on 60-cycle systems the ranges obtainable are from 54 to 66 cycles or from 58 to 62 cycles. The narrow range scales are supplied for use on inter-connected systems and applied principally to power or load dispatching.

United Tool & Die Dial Caliper

A DIAL caliper designed to measure drawn work, castings, forgings and other parts, has been placed on the market by the United Tool & Die Company, 324 Ann St., Hartford, Conn. This caliper makes use of an Ames indicator graduated to read 0.010 in.; the total measurement being to 2 inches.

One arm is detachable to permit replacing with any special arm to suit the customer's requirements. The dial caliper is made in two sizes; 5, and 9 inches.

TRADE LITERATURE

You Should Know About

Copies of literature which is described on this page can be obtained by writing to the manufacturer whose name and address are mentioned. It is always advisable to state the name and number of bulletin or catalog desired, as given in these columns.

(62) WASTE ELIMINATION—A 22x34-in. wall chart outlining "How and Where to Cut Waste."—Elliott Service Company, 242 West 55th St., New York, N. Y.

(63) MATERIALS HANDLING—Folder, Tramrail systems for handling overhead loads in the textile industry.—Cleveland Electric Tramrail Division of The Cleveland Crane & Enginering Company, Wickliff, Ohio.

(64) CIRCUIT BREAKERS—Circular 1705-B, 22 pages on Type CL carbon circuit breakers.—Westinghouse Electric & Manufacturing Company, E. Pittsburgh, Pa.

(65) WELDING—Bulletin No. 62, "A. W. P. Welds Under the Microscope."—Alloy Welding Processes, Ltd., Ferry Lane Works, Forest Road, Walthamstow, London, E.17, England.

(66) WATER TURBINES—Bulletin E-1132, small water turbines of the reaction, inward flow, or vortex type.—De Lavel Steam Turbine Company, Trenton, N. J.

(67) LUBRICATION—High-pressure, automatic, by-pass oil filter, Fig. 1116, for fuel and lubricating oils.—Wm. W. Nugent & Company, 410 N. Hermitage Ave., Chicago, Ill.

(68) STANDARDS—"Lumber," fourth edition, Simplified Practice Recommendation R16-29.—U. S. Department of Commerce, Bureau of Standards, Washington, D. C.

(69) ARC WELDING—Folder GEA-874E, Type WD-200A arc welder, belt, motor, or gas-engine drive; stationary or portable; self-excited, variable-voltage, single-operator.—General Electric Company, Schenectady, N. Y.

(70) ELECTRIC HEATERS—Leaflet GEA-117A, Type Y-2092 oil immersion heater.—General Electric Company, Schenectady, N. Y.

(71) MOTOR AND STARTING SWITCH—Leaflet 20429, Type RH motor, and drum-type starting switch.—Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.

(72) SWITCHING EQUIPMENT—Folder GEA-1193, automatic switching equipment for emergency operation of power lines.—General Electric Company, Schenectady, New York.

(73) SAFETY SWITCHES—Revised page 11 for catalog 14, Type A safety switches, single throw, fusible, for cartridge fuse, and interlocking.—Trumbull Electric Company, Plainville, Conn.

(74) ARC WELDING—Folder GEA-1009B, Type WD-300A arc welder, Buda gas-engine-driven, 300-amp., 24-volt N.E.M.A. rating.—General Electric Company, Schenectady, N. Y.

(75) CLEANING MACHINE—Bulletin, "Colt Autosan" metal parts cleaning and drying machines.—Colt's Patent Fire Arms Manufacturing Company, Autosan Machine Division, Hartford, Conn.

(76) WELDING—Circular A-43 lists the complete line of Weldite welding rod. General information such as standard rod sizes, lengths, packing, and other details are also included.—Fusion Welding Corporation, 103rd St. and Torrence Ave., Chicago, Ill.

(77) OIL CIRCUIT BREAKER—Leaflet 20451, FO-22 weatherproof oil circuit-breaker, rated at 400, 600, and 800 amp., 7500 volts.—Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

(78) GROUNDING—"Grounding Notes," a monthly publication.—Hubbard & Company, Pittsburgh, Pa.

(79) ROLLER BEARINGS—76-page catalog, containing installation sketches, load capacity tables, and photographs of roller-bearing-equipped machinery.—American Roller Bearing Company, Pittsburgh, Pa.

(80) ELECTRICAL EQUIPMENT—Bulletin GEA-1232, "Electric Equipment for Handling Heavy Material."—General Electric Company, Schenectady, N. Y.

(81) HEATING SYSTEM—Bulletin 130, Lee hot air heating system.—Lee Air Heater Company, 22 W. Rayen Ave., Youngstown, Ohio.

(82) RECORDING INSTRUMENTS—Catalog 7501, indicating and recording remote type instruments for measuring pressure, liquid levels, flows, and for indicating positions.—Brown Instrument Company, Philadelphia, Pa.

(83) MAGNETIC SWITCHES—Leaflet GEA-19F, CR7006-D5 and D7 a.c. inclosed magnetic switches for a.c. motors.—General Electric Company, Schenectady, N. Y.

(84)—CONTROLS—Bulletin DB-10, "Practical Pointers on the Selection of Motor Control."—Cutler-Hammer, Inc., 133—12th St., Milwaukee, Wis.

(85) MOTION PICTURES—Bulletin GES-402A contains descriptions and illustrations of motion pictures and lectures showing the development, manufacture, and applications of electric products. These films are intended for exhibition in the interest of education, commercial development and public welfare and may be obtained without charge except for the cost of transportation.—General Electric Company, Schenectady, N. Y.

(86) ELECTRICAL EQUIPMENT—Leaflet 20455, "Electrical Equipment for Cable Tool Drilling," single and twin-motor units.—Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

(87) WATER CONDITIONING—A 16-page bulletin, "The Economy of Soft Water," describes the Elgin Zeolite water softening system.—Elgin Softener Corporation, Elgin, Ill.

(88) INSTRUMENT SWITCHES—Folder GEA-1045-A, Type CL-2 control and instrument switches for electrically-operated governors and rheostats and instrument transfer.—General Electric Company, Schenectady, N. Y.

(89) ELECTRIC TOOLS—Catalog 30, the complete line of "Ideal" electric drills, screwdrivers, and grinders.—The Schauer Machine Company, Cincinnati, Ohio.

(90) STEEL PRODUCTS—Buyers' Guide, nickel alloy steel products, January 1, 1930.—The International Nickel Company, Inc., 67 Wall St., New York, N. Y.

(91) LUBRICATION—"The Relation of Carbon Residue to Lubricating Performance," *Lubrication*, January, 1930.—The Texas Company, 17 Battery Place, New York, N. Y.

Coming Events

American Society of Mechanical Engineers—Fiftieth Anniversary, April 5-9, 1930. New York, Hoboken and Washington.

American Welding Society—Annual meeting at society headquarters in New York City, April 22 to 25. Secretary, M. M. Kelly, 33 W. 39th St., New York City.

New England Association of Commercial Engineers—National Power Show held in connection with the International Textile Exposition, April 28 to May 3. Mechanics Bldg., Boston, Mass. J. W. H. Myrick, Treasurer, 53 Devonshire St., Boston, Mass.

American Gear Manufacturers Association—14th Annual Meeting, May 1, 2, and 3. Hotel Gibson, Cincinnati, Ohio. T. W. Owen, Secretary, 3608 Euclid Ave., Cleveland, Ohio.

National Fire Protection Association—1930 annual meeting, May 12, Atlantic City, N. J.

National Association of Foremen—Convention, June 6 and 7. Civic Auditorium and Chamber of Commerce, Toledo, Ohio. Harry J. Baumker, Convention Secretary, 316 10th St., Toledo, Ohio.

American Society of Mechanical Engineers—Semi-annual meeting of the Society, June 9 to 12, 1930. Hotel Book-Cadillac, Detroit, Mich.

National Electric Light Association—Annual Convention at Municipal Auditorium, San Francisco, Calif., June 16-20, 1930. Secretary, A. J. Marshall, 420 Lexington Ave., New York City.

Association of Iron and Steel Electrical Engineers—Iron and Steel Exposition. Broadway Auditorium, Buffalo, N. Y., June 16 to 20 incl. John F. Kelly, Managing Director, Empire Building, Pittsburgh, Pa.

American Institute of Electrical Engineers—Annual Summer convention, June 23 to 27, Toronto, Ont. Annual Pacific Coast convention, Sept. 2 to 5, Portland, Ore.

INDUSTRIAL ENGINEERING'S DATA SHEETS

Two Methods of Finding Angle of Pipe Intersection

A pipe fitter may often desire to discover the correct angle between two intersecting pipe lines which he intends to install. This may readily be done with either a carpenter's square or a 2-ft. folding rule in the following manner:

Stretch a stout string or a piece of mason's line at the center line and in the direction of the proposed lines of pipe, intersecting at the desired point. To get the angle between these two lines so that proper fitting may be made, proceed as follows:

Method A. Using Straight Edge and Carpenter's Square

Lay long leg of the square or straight edge against the direction taken by the main pipe, shifting the square backward and forward until the shorter leg is intersecting at exactly 12 in. from the corner as shown in Fig. 1. Read the

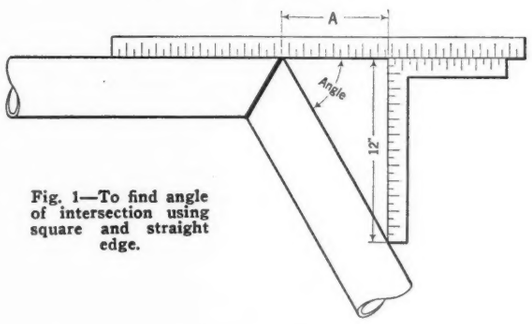


Fig. 1—To find angle of intersection using square and straight edge.

distance *A* on the longer leg of the square or straight edge and take out the corresponding angle from the following table:

Angle, Deg.	Length of *A*	Angle, Deg.	Length of *A*
5	11 ft. 5⅛ in.	50	10⅛ in.
10	5 ft. 8 in.	55	8⅜ in.
15	3 ft. 8¾ in.	60	7 in.
20	2 ft. 9 in.	65	5⅝ in.
25	2 ft. 1⅝ in.	70	4⅜ in.
30	1 ft. 8¾ in.	75	3¼ in.
35	1 ft. 5⅛ in.	80	2 in.
40	1 ft. 2¼ in.	85	1⅛ in.
45	1 ft.	90	0

Method B. Using 2-Ft. Folding Rule

Stretch tight strings as before and lay the rule into their intersection as shown in Fig. 2, and

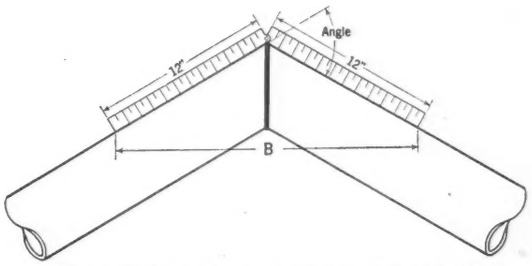


Fig. 2—To find angle of intersection using 2-ft. rule.

with another rule, measure distance *B* between tips. Take out the angle from the following table:

Angle, Deg.	Length of *B*	Angle, Deg.	Length of *B*
10	23 15/16 in.	55	21 5/16 in.
15	23 13/16 in.	60	20 13/16 in.
20	23 11/32 in.	65	20¼ in.
25	23 15/32 in.	70	19 31/32 in.
30	23 3/16 in.	75	19 3/32 in.
35	22 29/32 in.	80	18 13/32 in.
40	22 3/16 in.	85	17 11/16 in.
45	22 3/16 in.	90	16 31/32 in.
50	21¾ in.		

These methods, of course, are also useful for measuring the angle of deflection of a piece of pipe already installed. In that case, Method A with the straight edge and carpenter's square is best applied on the outside of the bend and Method B using the 2-ft. rule on the inside of the bend.

It also should be remembered that Method A is much more accurate for small angles while Method B should be used for angles approaching a right angle turn.

Courtesy of The Linde Air Products Company

INDUSTRIAL ENGINEERING'S DATA SHEETS

Fabricated Multi-Piece Pipe Bends

The layout of a multi-piece bend is governed by three factors; namely, the included angle of bend, the number of pieces, and the radius of the bend. Having decided upon these factors, the first operation consists of determining the length of the shortest element of the individual sections making up the bend.

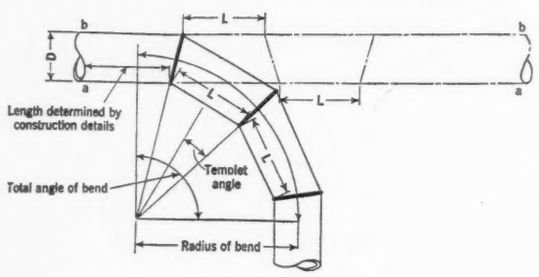


Fig. 1—Multi-piece bend.

The following formula gives a method for determining this length mathematically:

$$L = (2R\text{-}D) \tan T.A.$$

Where L = Length of shortest element of sections, in inches.
R = Radius of bend, in inches.
D = External diameter of pipe, in inches.
T.A. = Templet Angle

$$= \frac{\text{Total angle of bend}}{2\ (N\text{-}1)}$$

N = Number of pieces in bend.

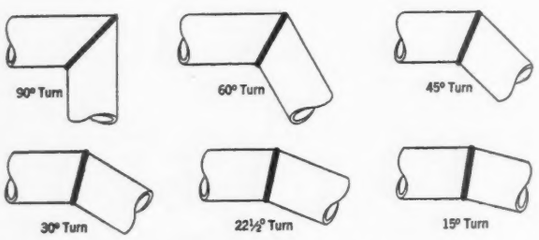


Fig. 2—Two-piece fabricated bends.

As an illustration of the application of the foregoing formula, the following example is given:

Required: To lay out on a 12-in. pipe, a 4-piece, 90-deg. bend, radius of 60 inches.

Solution:

$$T.A. = \frac{90°}{2\ (4\text{-}1)} = 15°$$

$$\text{Tan T.A.} = \tan 15° = 0.2679$$

$$L = (2R\text{-}D) \tan T.A. =$$

$$(2\times60 - 12.75)\ 0.2679 = 28.78 \text{ in.}$$

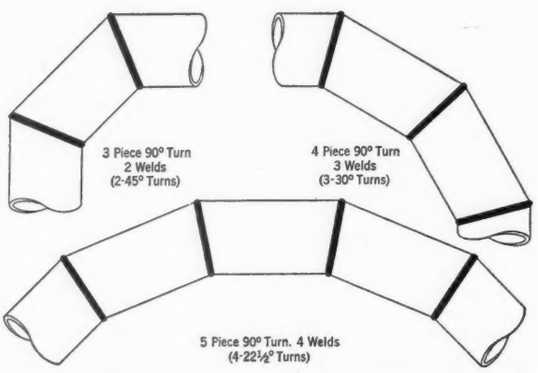


Fig. 3—Three-, four- and five-piece, 90-deg. bends.

Representative 2-piece bends are illustrated in Fig. 2 in the opposite column.

Multi-piece bends shown in Fig. 3, can be fabricated with almost any radius and number of pieces.

Courtesy of The Linde Air Products Company

Management Congress and Equipment Exposition Have Successful Inauguration

TWO new ventures were successfully launched in Chicago during the week of March 3—a National Management Congress and a National Industrial Equipment Exposition. Approximately 1,000 people were registered for the meetings and probably a good many attended without going through that formality. It is estimated that 10,000 attended the exposition. The visitors were of high order, meetings were carried on with genuine enthusiasm, and orders were reported booked by exhibitors.

Held at the same time were the national meeting of the Materials Handling Division of the American Society of Mechanical Engineers and the first Industrial Marketing Conference by the Industrial Marketing Division of the American Management Association. One of the group sessions of the congress opened this year's campaign for waste elimination in industry.

Inspection trips were made to the plants of the Western Electric Company, W. F. Hall Printing Company, Edison Electric Appliance Company, Swift & Company, Stock Yards, Inland Steel Company, Indiana Harbor, Ind., Whiting Corporation, Harvey, Ill., State Line Generating Station, Commonwealth Edison, Chicago Underground Tunnel.

Of especial interest to readers of *Industrial Engineering* was the session on Plant Maintenance presided over by L. C. Morrow, editor of that publication. Abstracts of the three addresses made are printed on the following pages. These abstracts are almost complete presentations of the papers. The papers were "Budgeting for Upkeep," by J. L. Kirsch, General Plant Engineer, Continental Can Company, Chicago; "Budgeting for Maintenance," by R. R. Rees, Mgr. Const. & Maint. Div., Packard Motor Car Company, Detroit, Mich.; and "Budgeting for Maintenance," by E. C. Brandt, Asst. Works Mgr., Westinghouse Electric & Manufacturing Company, E. Pittsburgh, Philadelphia.

Maintenance Session Brings Out Fundamental Problems

In the Materials Handling meetings papers presented included the following: "Conveyor Handling Methods of the Chicago Daily News," by Matthew W. Potts, Engineer, Alvey-Ferguson Company, New York City; "The Use of Portable Conveyors," by E. L. Benson, Manager Conveyor Division, The Barber-Greene Company, Aurora, Ill.; "Shipment of Goods on Skid Platforms," by F. J. Shepard, Jr., Lewis-Shepard Company, Watertown, Mass.; "Industrial Plant Design and Operation as Affected by Transportation Between Departments," by Willard Brinton, Terminal Engineering Company, New York City; "The Industrial Tractor Trailer Method of Materials Handling in the Meat Packing Industry," by A. D. Shanks, Manager Packing Industries Dept., Mercury Manufacturing Company, Chicago, Ill.; "Coordination of Handling Equipment in the Packing Industry," by A. W. DeVout, Engineer, Swift & Company, Chicago, Ill.; "Recent Developments of Materials Handling in the Merchandise Building, Kearny, N. J.," by C. K. Prevear, Engineer, Western Electric Company; "Materials Handling in an Automotive Frame Plant," by E. W. Redlin, Assistant Works Manager, C. A. Smith Corporation, Milwaukee, Wis.; "Designing for Safety in Materials Handling," by R. R. Hucke, Engineer, General Electric Company, Schenectady, N. Y.; "Effect of Modern Materials Handling on Materials, Inventory, and Scrap," by E. J. Barney, Superintendent of Materials, Frigidaire Corporation, Dayton, Ohio; "Hidden Costs in Materials Handlings," by J. I. McCormick, Superintendent Plant Planning, Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa.; "What the Materials Handling Equipment Manufacturers Need to Know in Order to Make a Successful Installation," by N. H. Preble, Mechanical Handling Systems, Inc., Detroit, Mich. It is expected that abstracts of some of them will appear in the April issue of *Industrial Engineering*.

There follows a list of the exhibitors showing at the exposition. The products shown fall into three general classifications: Management Equipment, Materials Handling Equipment, and Plant Service Equipment.

Alphabetical List of Exhibitors at The National Industrial Exposition

Acme Steel Company, strapping tools.

Alexander Bros., Inc., Tentacular belts.

All-Steel-Equipment Company, sheet steel, boxes and cabinets.

Alvey-Ferguson, overhead trolley conveyors.

American Electric Motor Company, inclosed electric motors.

American Engineering Company, monorail electric hoists.

American Pulley Company, hand trucks, Sprucolite pulleys and conveyor rollers.

American Society of Mechanical Engineers, waste elimination campaigns.

Anchor Spray Paint Company, waterproof cold water paint.

Appleton Electric Company, threaded and threadless conduit fittings, lighting fixtures.

Atlas Car & Manufacturing Company, elevating platform trucks.

Automatic Electric, Inc., automatic industrial telephone, fire alarm, and signal systems.

Automatic File & Index Company, filing cabinets and systems.

Automatic Sprinkler Corporation of America, sprinkler and deluge systems.

Automatic Transportation Company, Inc., automatic electric industrial truck.

Backus, A. Jr. & Sons, woven wooden boxes and trucks.

(*Continued on page* 170)

Here's what they said about MAINTENANCE

BUDGETING

J. L. KIRSCH

WE know that all industries are organized and operated for the avowed purpose of making a profit for the owners. We know that it is good business whether we are conducting our own households, a manufacturing plant, a government, or any kind of an institution to see that expenditures do not exceed income, and that there is something left for a rainy day. That is only another way of saying that something should be left for the owners of the business as a return on their investment, and also for a reserve on extensions or new equipment. We know, too, that heedless spending has, most of the time, failed to lead to this desirable end and has often led a business into difficulties and disaster.

To avoid pitfalls such as the foregoing and to impress us that the management is enlightened and knows where it is going, a plan that will keep expenditures within income is a very desirable thing to provide. This is the reason for a budget.

A budget system may, therefore, be considered to be a forecast giving estimated expenditures for conducting or operating a concern for any ensuing or future period, and controlling these expenditures so that they are kept within the limits of the budgeted amount.

In organizing for a budget system there must be a very definite lineup with duties outlined in such a way that there will be no misunderstanding as to the relation of one department to the other. There must also be a co-ordination of all departments so that there will be a co-operation and an endeavor to make the budget a success. In other words a budget, like any other system installed in a manufacturing plant, must have the support of the entire organization in order to make it a success.

In making up a budget, which should be authorized by the chief executives of the business, all department heads should be asked to submit a budget of their own departments to a committee composed of all department heads, to be gone over by this committee carefully so that all expenditures may be pared down to a safe minimum, and then sent to the manager for approval.

To make up the estimates for any succeeding year or period, the actual costs of operating these departments during the past years can be obtained from the cost department and used as a comparison with budgeted figures for the future.

What has been mentioned before has general application, but as stated before, a general understanding of the subject is required before treating any particular phase of it, for what applies to any business as a whole must apply to a great extent to any department of that business.

In considering a maintenance department, one must first outline the scope and responsibility of the head of that department, for it should have a head in responsible charge who will be answerable for its performance. We designate that head as a plant engineer. He has supervision over all the activities of the plant except actual production, and the upkeep of production machinery.

A production superintendent looks after production, and a master mechanic is in charge of the upkeep of the production machinery. All the other activities of the plant such as safety, cleanliness, sprinklers, pipe fitting, plumbing, millwrighting, tracks and yards, watch service, power, light, and heat, the operation of motors and their condition, wiring for light and power, elevators, trucks of all kinds, the operation of plant equipment such as air compressors, gas machines, ventilating systems, belts, etc., belong to the duties of the plant engineer. He is also responsible for the condition of the plant as well as the keeping up-to-date of the appraisal system, and the installation of appraisal numbers for machines. He makes up a budget for his department and is required to control this budget so that expenditures are kept within the estimate.

We do not find it difficult to budget this department nor any of the other departments after the manner outlined.

Actual costs obtained from the cost department are used as the basis for the budget for any succeeding period and to these are made additions that may be required by reason of plant extensions, equipment extensions or any such expansion which would cause additional expense to any of the divisions previously outlined.

In our case, exercising close and careful control over expenditures has a tendency to make the department head watchful in avoiding any expenses which have not been authorized as a part of the budget. Also, there is a tendency not only to watch expenses closely, but to try to keep them below the budget. In many cases there is a saving shown at the end of the budget period between the budgeted amount and the actual costs.

Control of the budget is accomplished by making a comparison with actual costs at the end of each month.

Speakers:

J. L. KIRSCH
General Plant Engineer
Continental Can Company
Chicago, Ill.

R. R. REES
Plant Engineer
Packard Motor Car Company
Detroit, Mich.

E. C. BRANDT
Works Manager
Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

at the MANAGEMENT CONGRESS

In the case of an extraordinary expense which is not covered by the budget, we seek authority for the excess, and if approved, it is carried over until the end of the year to be charged off. No attempt is made to revise the budget each time this occurs. In this way a great deal of red tape is avoided, and the budget system does not become cumbersome.

Our budget is made for a year and is not changed for that period. For a large business, nation-wide, or perhaps international in its scope, a budget system or some such manner of control is almost imperative, for the management should have a picture before it at all times as to the way it is being operated and conducted.

What are the benefits of a budget system of control? It enables management to limit departmental or plant activities without restraining the business. It gives all concerned an opportunity to plan for the future. It is a deterrent to unbridled and extravagant expenditures, and in the end assures profits and dividends for the owners. It will not insure profits, but it is about the only means we have of being able to forecast what the condition of a business will be, providing some condition beyond our control does not intervene.

ORGANIZATION

R. R. REES

PLANT engineering duties today, as compared with ten years ago, are so dissimilar that they might not be recognized as functions of the same organization. What has brought this situation about might be charged to many conditions: the growth of industry, improved methods of manufacturing, and constant effort to decrease costs of production.

It also seems to be the trend to place as many responsibilities under one head as possible, thus eliminating the many subdivisions of organization that existed years ago. For this reason and because of the flexibility of plant engineering departments, each year has seen added responsibilities and new duties taken over by the plant engineer. To meet these conditions he has had, of necessity, to build up an organization to handle the many and diversified problems with which his division is confronted daily.

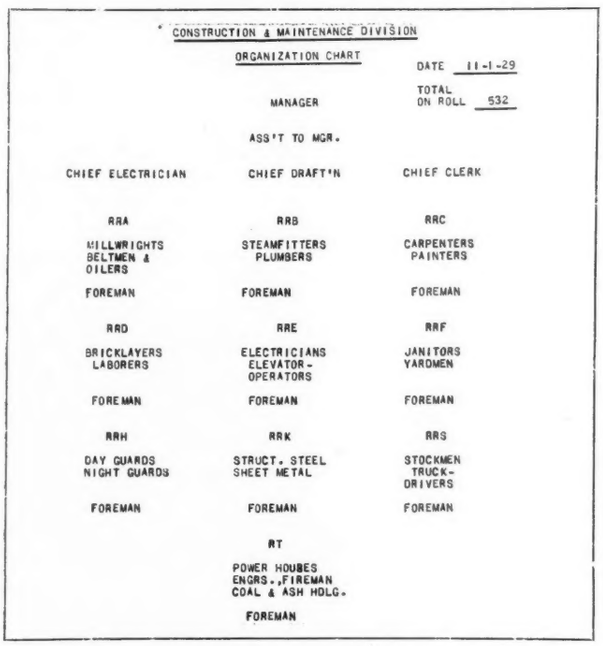


Chart I—An outline of the organization set up to handle two major subdivisions of work.

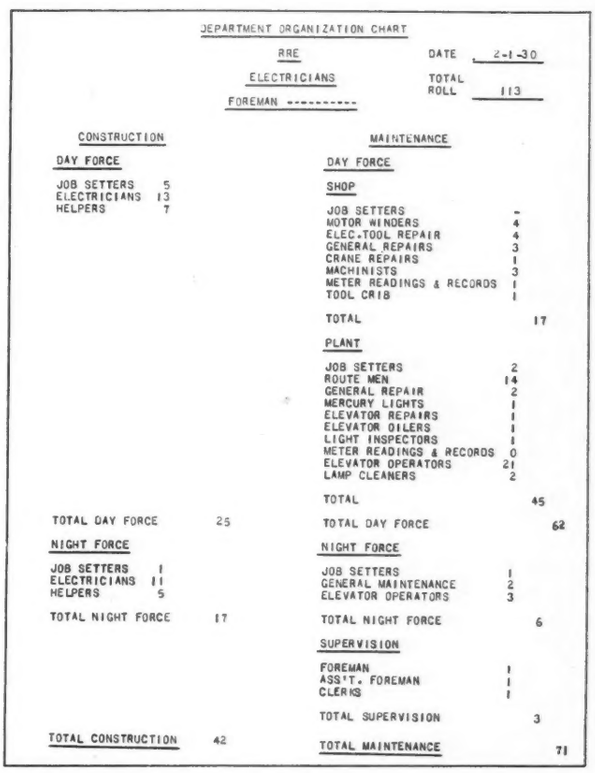


Chart II—The complete segregation of construction and maintenance men is shown in this chart.

In most of the larger industries the plant engineer is responsible for new construction as well as maintenance; therefore, his organization has been set up to handle these two major subdivisions of his work. This organization in our factory is shown in Chart I.

From this chart it will be seen that a comparatively large organization is necessary to carry out properly the respective duties of each division.

In our case new construction, plant alterations, and maintenance are all carried on by this division. How the division of labor is made in all departments for these activities follows.

Each department is headed by a foreman who is responsible for all activities. His department is subdivided into men allocated strictly to maintenance duties, and others for new construction and alteration work. Each of these groups is headed by a subforeman. By this subdivision of men and definite allocation of work the responsibility for various activities can be definitely fixed.

Chart II shows the electrical department organization, which brings out quite clearly the complete segregation of construction men from maintenance men. You will note in the maintenance organization that the different classifications of work are thoroughly split up, and necessarily so, because they clearly define the activities carried on, and the number of men in each activity. This permits setting up the labor load.

WORK LOAD REPORT FOR ALL CONSTRUCTION DEPARTMENTS

WEEK ENDING 2-13-30

DEPT.	LABOR ROLL CONST. D	CONST. N	MAINT. D	MAINT. N	HOURS ALLOWED C.	HOURS ALLOWED M.	HOURS CONST.	WORKED MAINT.	TOTAL HOURS WORK WORKABLE	HELD	TOTAL
RRA	12		16	5	405	995	591	1063½	545	385	930
RRB	23		14	5	810	905	1182	1006	1943	351	2294
RRC	15		11		540	495	514	446	157	---	157
RRD	4		11		135	495	379	363	205	9	214
RRE	21	1	33	3	730	1650	918	1801	2510	1430	3940
RRK	21	3	8		895	360	756	457	976	123	1099

Chart III—A typical Work-Load report for all construction departments.

I should like to explain just how maintenance costs are controlled from the standpoint of labor load and material costs. As stated previously, the number of maintenance men in the electrical department is definitely fixed, and represents approximately 3,550 labor-hours. Of this total, certain hours are charged to different accounts; namely, 5, 55, and 80. The 5 account represents the largest accumulation of all costs; therefore, its control will be treated in some detail.

We use what is known as a Work Load report for all departments. This report is made weekly and is set up as shown in Chart III. The labor load shows the allowance in number of men for maintenance, separate from construction. This value in turn is reduced to total labor-hours and another column for the hours actually worked on construction as well as maintenance.

From this weekly load report one can, at a glance, determine which departments have overrun their allowance and by how many hours. If the overrun amounts to anything appreciable, the foreman in charge is requested to submit a written report in explanation.

This labor load report has performed a most important function because it shows clearly whether any construction men have been used for maintenance, and also shows definitely the efficiencies of the respective departments.

With the labor load and labor cost under control, what then becomes the next important item? Here, it is the condition of the equipment in the factory, together with a record of its performance and a brief description of repairs and changes. To get a picture of this kind there has been made a physical inventory of the major equipment installed. This record is kept as shown in Chart IV.

A copy of this record is kept by the foreman responsible for the work and another is retained in the maintenance division office. When major repairs or alterations are made to any piece of equipment the foreman advises the office and the proper entry is made in the record. These data serve many purposes. They enable the plant engineer to measure the efficiency of different manufacturers' equipment. Again, they enable him to measure most accurately the life of different materials used.

Similar records, as shown in Chart V, are kept on each individual building of the factory.

In addition to a brief description of the repairs made, the cost of that work is also noted. This information becomes invaluable to the plant engineer in preparing his yearly budget. In a similar manner to equipment maintenance, the types and classes of materials are noted, which provides a "measuring stick" for comparison on future work.

One very important item that has helped to control maintenance expense and budget allowances is the performance of certain work on a definite schedule.

Items coming under this system now are window washing, lamp cleaning, floor scrubbing, etc. In addition to controlling expense by performing this work at regular intervals, it allows maintaining a definite standard of cleanliness. For instance, due to certain manufacturing conditions windows, floors, and lamps will become dirty in three weeks in some departments, whereas in others the period is two months.

By this same method definite periods for inspection of equipment are made so that ultimately everything will receive the necessary attention at specific intervals.

A much-discussed subject in relation to maintenance and construction is the standardization of materials and equipment. Personally, I am not a believer in too much standardization because of the hazard which

EQUIPMENT MAINTENANCE

CONVEYORS #32 -

DATE OF INSTALLATION	-	MARCH 20, 1923
DEPARTMENT INSTALLED	-	FINAL CAR ASSEMBLY
TYPE	-	SINGLE DRAG CHAIN
TYPE OF CHAIN USED	-	103
SPEED REDUCER	-	REEVES
MANUFACTURER	-	PALMER-BEE COMPANY

REPAIR DATA -

DATE	REPLACEMENT	CAUSE
12/1/25	MOTOR PINION	BAR CAUGHT IN CHAIN ON LINE
12/1/26	MAIN GEAR REPLACED	NATURAL WEAR

Chart IV—A physical inventory of the major equipment installed is maintained in this manner.

many times accompanies such a policy. At the same time I do not believe in wholesale purchase of such items from the selling field at large.

Our plan is to have the maintenance division write a specification covering the material or equipment, drawing it up so as not to confine it to one manufacturer's product. This specification is then turned over to the purchasing division, which calls in different vendors to submit samples which they consider comply with the specification. These samples are then examined by the maintenance division which furnishes the purchasing division with a list of the items that have been approved. Actual purchases are then made on a strictly price basis.

In connection with new construction activities the plant engineer is confronted with the problem of determining whether he should build up his construction organization to take care of that work or whether it should be done on a contract basis.

Our plan is to have an organization composed of an average number of men with the required number of supervisors. Such an organization will take care of a definite amount of work, and when the activities increase beyond that organization the remainder of the work is let out to contractors.

Does the plant engineer give sufficient study and thought to the economics of his position? Isn't it true that the cost of maintenance has come to represent a very large percentage of the plant's operating cost? This latter condition being true, it necessitates a careful financial analysis of each major item of expense, which record should be carefully kept at hand.

To satisfy the need for information of this kind we have plotted a curve pertaining to major items for

BUILDING MAINTENANCE

BUILDING NUMBER - 12
DATE OF CONSTRUCTION - 1916
NUMBER STORIES - 5
AREA PER FLOOR - 18,560 SQUARE FEET

REPAIR DATA -

2/1/27	- REMOVED MAPLE FLOOR AND SLEEPER FILL, REPLACED WITH 2" CONCRETE SUB-BASE AND 2¼" WOOD BLOCK -	$10,500
5/15/27	- REPAIRED EXTERIOR CONCRETE	
	PAINTED EXTERIOR CONCRETE - TOCH BROS. -	$ 6,500
	PAINTED EXTERIOR TRIM - DETROIT GRAPH.GREEN	$ 3,500
10/5/28	- INSTALLED MAZDA LIGHTING, 1ST AND 3RD FLOORS 300 WATTS PER SQUARE FOOT) -- R.L.M. REFLECTORS) -	$ 5,500
6/5/28	- REMOVED OLD ROOFING AND REPLACED R. C. MAHON COMPANY -	$ 3,600

Chart V—Records of this kind are kept on each individual building of the factory.

the past twelve years, which has proven invaluable each year in preparing new budgets for plant operation.

In the foregoing, I have attempted to evolve the essentials to good management in plant engineering departments. They are:

1. Necessity of proper organization.
2. Discrimination as to size of organization.
3. Definite period of inspection of equipment.
4. Careful analysis of operating costs.
5. A proper plan whereby a department will operate on a budget control system.

OPERATION

E. C. BRANDT

A BUDGETING system is recognized, I believe, by American industry as one of the outstanding things we must have at all times. As I have studied this subject for a number of years and have had to operate under a budget, later helped to make that budget up and finally, after 25 years, have to control that budget, I am going to give you the benefit of some of my experience.

It is evident that any budget plan for your plant or business would be like laying out the budget for a home. I believe there would be just as many diversified elements in it. In my opinion you must know a lot of things about your plant, about the age of your buildings, their construction, their stability, and a lot of other things.

Every plant that has a concrete building would not have the same account for depreciation, but I believe we must, in considering any type of building, follow the National Association of Cost Accountants' set-ups which cover this matter. I believe that any company which does not follow some set percentage of depreciation in lining up its budget will sooner or later find itself on a toboggan.

It is essential for anyone who controls or makes up a budget to have some idea of the source of the finances, of where the money is going to come from for any work that has to be done. I do not mean by that that it is not good business to venture into rehabilitation without finances, but I do believe that by having a budget system, or by having some general idea of your business, you are going to find the lender more ready to help you rehabilitate anything you may have in mind as an expense prior to your production.

You must have the history of a plant and know something about the wear and tear on the property and the equipment before you can intelligently approve a budget.

One of the finest ways of getting this information is to put a group of planning engineers into a plant. I shall have to use some of our plants as illustrations, although I have appraised and gone over many plants with this objective in mind, and I find quite a diversity of conditions.

The ability of your engineers or plant planning men to estimate what it is going to cost to maintain a plant or rehabilitate it, must come to a certain extent by perfect training of those men, coupled with experience.

During the past several years I have inaugurated a

maintenance inspection department in our company. These men do no estimating or repair work, but they do the inspecting and look the work over. They report what they think, regardless of whom it affects. They make recommendations for betterments. These reports are turned over to the estimating engineers or plant engineers. This plan is one of the finest things I have found in some 25 years' experience.

This inspection department works very closely with the plant engineering group. To give you some idea of what this inspection department's possibilities are, I have here a five-year layout covering a plant with some 64 acres under roof, with more than $50,000,000 in equipment assets, and a like amount in buildings and grounds. This is what I call an ideal condition of budgeting, and financing that budgeting in the most economical manner. It involves the creation of a surplus for depressions or depreciation that may occur.

We all have the same fault: when business declines, maintenance declines, and we start immediately to cut down the expense of our maintenance. I know of no company that does not have that in mind. The manager says, "Well, we can easily save $100,000 a month by calling up the maintenance department and telling them to lay off 285 men." That is fine business! When a manager gets to a certain point he ought to have a nice, big maintenance program and a large group of maintenance men, so that when the executive management calls on him it takes only about 24 hours to stick a feather in his hat and say, "Boss, we have just reduced expenses $100,000 a month, starting tomorrow morning." Whether this is false economy or not is something to decide as time goes on.

I do not believe in the "swing the scythe" method of reducing expenses. The policy of laying out a budget and controlling it is one thing. The source of finances for that budget is another thing. I should like to manage a business that does not fluctuate and has a straight-line loading year in and year out, but I get a greater kick out of managing a diversified business where, when you go from one division or department to another, the law of averages keeps you busy.

Controlling the Budget

In the sliding-scale budget control system, after laying out by divisions, by account numbers, by the amount of money allocated to each of these expenses and the purpose intended, we start with a 30 per cent departmental loading; that runs to the 100 per cent loading point, or the maximum output of your department labor or shipping production. I believe we can concede that the average plant, when loaded to 85 per cent, is practically at the 100 per cent point. If you have an 85 per cent productive load in your plant, you might say that you can spend a 100 per cent dollar for maintenance and rehabilitation.

Activities in some departments will fluctuate probably three or four days or a week out of each month. That week would be a Godsend to certain departments that go like the dickens to feed the main assembly sections, and should be the period for overhauling.

That department would then drop down to a 50 per cent operating capacity, and you immediately have an amount of money allocated for such activity on that 50 per cent basis. That is the time to spend the money.

In my judgment you can not lay out this annual budget on the basis of a five-year look-ahead and have some kind Board of Directors say, "We are in receipt of your $2,000,000 appropriation for 1930, and it is hereby resolved that you can have that money." They have a measuring stick which usually is the productive labor output of a division. On that basis our company allocates the amount of money to be spent for this important phase of industry.

After that amount is allocated on a 100 per cent load basis, the superintendent can readily calculate his allowance by the load he has in his department. He knows that as nobody else does. You might call it a formula for his expenditures, which is a percentage of his productive labor for his shipping or selling department. I think that is important, because when any reductions are to be made, there are fixed rules and regulations for that reduction.

When Overhauling the Plant

There are other types of maintenance with which we are all familiar. They include the complete overhauling of a plant or department that is to be changed over for a new line of production or a new line of manufacture. In this case the National Association of Cost Accountants is very definite and has certain ideas that should be accepted, as they cover the rehabilitation of such plants and departments on the expense-prior-to-production basis.

In this case we call in the inspectors, planning managers, and works engineers, and estimate what it will take to modernize the plant, whether parts of it should be torn down, whether it is economical to have this amount of money spent on a certain building for repairs and renewals. That money is then provided for in extraordinary expenses prior to production, and does not enter into our standard operating maintenance budget program.

The same thing is true if we have a group of machine tools that have been going pretty hard and should be overhauled.

The procedure for plant buildings and ground maintenance may be used for the mechanical or machine tool branch of any business. On our machine tools we have a certain percentage of the productive labor of every department and activity allocated for the maintenance of that equipment. It is charged to the indirect factory expense of our total works delivery cost. By that fixed percentage superintendents can accumulate a surplus in their monthly accounts, whereby they can withhold the overhauling of equipment for a period of four to five months.

If we have a half-dozen turret lathes of one type, or boring mills, or whatever it may be, I have found it economical to send those six turret lathes at one time to the shop mechanical maintenance division for overhauling. We can then apply an incentive bonus system for our maintenance work on these six lathes.

I commenced this procedure two years ago in February, and it has been successful so far. I think there are wonderful possibilities in it, as we have saved some $250,000 a year over our budgets.

We have a great deal to think about in bonus systems and incentive wage systems. We do care what our operators and men think of the bonus possibilities and of the money they might earn by their efforts. We care, as managers or supervisors, how we dish out these incentives and what bonuses we pay for certain work.

I do not believe there is any use in trying any kind of an incentive wage system on any work unless you first sell it to your operating force. You get into enough trouble if you do sell it to them, let alone not selling it to them.

We want now to get to the controlling of budgets under an incentive plan for the workmen and, if you please, the supervisory force. Again, I believe in getting the history and facts.

All of our maintenance men, especially tradesmen, as we call them in operating an open shop, are paid 60 per cent of the union wage rate. However, that is based on working every day, as compared with union help, and the men can establish a certain task for themselves by doing an honest day's work for that rate, and can increase that rate by an incentive-measured, day-work system.

The incentive-measured, day-work system is a means of obtaining the history and accomplishments whereby the operators are allowed, for argument's sake, ten hours at their fixed day rate; if they do the job in eight hours, they got ten hours at their fixed day rate. This system should be applied to such operations as laying a sidewalk, building a stack, or replacing a roof. There are times when you have to be a sport and gamble with your operators, because every minute they are listening to you they are gambling with you. By fair dealing we gain their confidence.

That is what is going on in our plants at this time. It was surprising to see what a short time it has actually taken in our plant to record these facts. Most of you know the size of our plant at East Pittsburgh, and it has been outstandingly surprising to me that in less than two years' time our standard time men and our works engineers have been able to tabulate practically every operation. We have every kind of maintenance work one can imagine. I personally set a goal of about five years in which to obtain this history. We have the history, and we have it in such a way that we can set these standard times and tasks.

Co-ordination Reduces Maintenance

I wish to give you an idea of some of the things we have learned from tabulating this history which make for more economical maintenance. For example, all of the elevator operators and cranemen report to the maintenance engineer—not to the production department. Some people never heard of such a thing. However, the operators know better than anybody else the details of what is wrong with the cranes and elevators, and I endorse the practice of having them report to the maintenance engineer in any plant. It brings about a co-ordination between operators and maintenance inspectors, repairmen, and supervision, that is outstanding.

This group of elevator and crane operators can be switched from department to department in case of a layoff or absence on account of sickness. If there are two men off in the shipping department (and it does not do to have men off in the shipping department), the supervisor is able to put two trained crane operators there for that day.

The crane operator does not make a lift unless he knows the chain, slings, hooks or anything that goes to make crane lifts is in good condition. He is instructed by the maintenance department in the operation of that crane. I endorse that procedure.

The power house in its entirety reports to the works engineer, and I want to give some outstanding facts of what it has meant to have the power house and all of our facilities under the maintenance superintendent. For one thing it has decreased our maintenance about 15 per cent. I have not been able to find another power house anywhere that is paying its operators on an incentive system. This was another venture.

Bonus System in Power House

We had, in 1927, 123 men in our power plant. Those men produced in steam and kilowatt-hours an average output of $486 per month. We got 1,298,000 lb. of steam per man, with a kilowatt-hour cost of $0.0114. We studied our maintenance and operation with a view of applying an incentive bonus to these activities. In the first year, 1928, our output per man was increased to $540, with 1,645,000 lb. of steam per man, and our kilowatt-hour output cost us only $0.00817. We reduced the force from 123 men to 103 men.

They voluntarily asked to have the wage incentive group system applied to the power house. That made me feel very happy. We had oilers, wipers, meter tenders, water tenders, sweepers, and so forth—all of the men necessary around a power house. We found the wipers became oilers, the meter readers became wipers, the water tenders became wipers, and with the incentive that had been established between the workmen and the management this group was reduced to 97, where it stands today.

With our power house maintenance dropping 15 per cent in the past 24 months, our output per man is $623. We get 1,755,000 lb. of steam per man at a cost of $0.00768 per kilowatt-hour. That is one of the big things I should like to leave with you.

I am going to give you a summation of what I think is a pretty healthy budget controlled by departments through one central engineering source which reports directly to the management. Our budget, estimated for 1929 by months, totaled $2,442,850. It was based on the sliding scale of activity we anticipated through the estimated sales and deliveries by our sales and production departments. The actual cost of that $2,442,850 worth of work was $2,427,000. Those are our figures and they do not lie. They are facts. It was too good a showing and I hated to bring it here, because it looks like a report to the boss. However, I got some real history of my own business last night. I checked and rechecked, and those are the facts. That is about the way our budget was controlled last year.

With our sliding-scale basis and the slight decline we are all feeling in business, I did not call in our engineers and tell them, "Whack here, there, and everywhere." I said, "My judgment is that you and each of your superintendents should immediately fall back on about the 70 per cent curve," and that is what is being done.

We have given them 60 days to do it in. I believe in that. It gives the boys who are going to be laid off or furloughed a chance to look around and go home and tell wifey and the kids, "I am not laid off; I have just been given a vacation in the winter, although I don't like vacations in the winter." It helps keep the morale of the employees where it rightfully belongs.

(*Continued from page* 163)

Barber-Greene Company, portable belt conveyors and loaders.
Barrett-Christie Company, electric grinders and saws.
Barrett-Cravens Company, tier lifts, power- and hand-operated.
Bell & Howell Company, industrial motion pictures and equipment.
Benjamin Electric Manufacturing Company, lighting fixtures.
Bigelow, Kent, Willard & Company, Inc., consulting engineers.
Box Crane & Hoist Corporation, electric hoists.
Brookville Locomotive Company, industrial gasoline locomotive.
Burton Holmes Lectures, Inc., industrial motion pictures.

J. I. Case Company, Inc., gasoline tractors.
Chase, Frank D., Inc., engineers and architects.
Chicago Pulley & Shafting Company, pulleys, shafting, bearings.
Chisholm & Moore Hoist Corporation, trolley hoists.
Clark Tructractor Company, gasoline tractors.
Cleveland Electric Tramrail Company, tramrail systems.
Cling-Surface Company, belt dressing.
Clipper Belt Lacer Company, belt lacer.
Combustioneer, Inc., automatic coal burner.
Commercial Credit Company, credit organization.
Cory & Kobert, Inc., publicity and public relations counselors.
Currie Manufacturing Company, industrial truck casters.

Do-More Chair Company, chairs for office and factory.

Ebinger, D. A., Sanitary Manufacturing Company, industrial wash basins and drinking fountains.
Economy Engineering Company, elevating platform truck.
Edison Storage Battery Company, electric storage batteries.
Electric Storage Battery Company, electric storage batteries.

Factory & Industrial Management, a publication—editorial exhibit.
Fairbanks-Morse Company, turbine driven centrifugal pumps, scales, Flex-Mor drive.
Faultless Caster Company, industrial truck casters.
Ford Motor Company, delivery trucks.

General Electric Company, electric water cooling systems.

Haynes Corporation, Manit wage incentive system—charts—graphs.
Hough Shade Corporation, shades for industrial sash.
Hughes-Keenan Company, cranes, truck dump bodies.

Industrial Digest, a publication—editorial exhibit.
Industrial Engineering, a publication—editorial exhibit.
Industrial Power, a publication—editorial exhibit.
International Harvester Company of America, gasoline tractors.

Jones, W. A., Foundry & Machine Company, worm- and spur-gear speed reducers.

King-Seeley Corporation, distant-reading depth gages.

Lakeside Manufacturing Company, electric clocks and fire alarm systems.
LaSalle Extension University, industrial training courses.
Lewis, G. B., Company, woven wooden trucks, boxes and trays, Masonite trucks.
Lewis-Shepard Company, tiering machines, Jack-Lift trucks.
Lothrop Angle Steel Equipment Company, steel office furniture and cabinets.
Louden Machinery Company, monorail hoists.

Maintenance Supply Company, Rust-Oy, a protective coating for metals.
Materials Handling & Distribution, a publication—editorial exhibit.
Mathews Conveyor Company, gravity, roller, and live conveyors.
Mechanical Catalog, catalog exhibit.
Mechanical Engineering, a publication—editorial exhibit.
Mechanical Handling Systems, chain conveyors.
Mercury Manufacturing Company, gas and electric industrial trucks and trailers.
Mill & Factory Illustrated, a publication—editorial exhibit.
Milwaukee Electric Crane & Hoist Corporation, electric traveling cranes and hoists.
Museum of Science and Industry, historical industrial exhibit.

National Safety Council, industrial safety bulletins.
Northwest Engineering Company, crawler cranes.
Nutting Truck Company, industrial trucks and casters.

Ohio Brass Company, waste elimination campaign posters.
Olson, Samuel, & Company, pneumatic tube conveying systems.

Pennoyer Merchants Transfer Company, industrial transfer system.
Plibrico Jointless Firebrick Company, jointless furnace lining.
Powell Pressed Steel Company, pressed-steel platforms and boxes.
Power Transmission, a publication—editorial exhibit.
Public Service Company of Northern Illinois, electric service.
Pyrene Manufacturing Company, industrial fire extinguishing systems, tire chains.

Railway Purchase & Stores, a publication—editorial exhibit.
Rawlplug Company, screw anchors.
Reading Chain & Block Company, monorail hoists.
Robbins & Myers, Inc., hoists and cranes.
Rotor Air Tool Company, portable pneumatic tools.
Roller Bearing Company of America, straight radial-type roller bearings.
Revolvator Company, platform lift trucks and tiering machines.

Saginaw Stamping & Tool Company, conveyor wheels, trolleys, casters and trucks.
Sarco Company, Inc., temperature control—steam traps and heating specialties.
Self-Cleaning Strainer Company, strainers for oil and air lines.
Service Caster & Truck Company, trucks and casters.
Shepard-Niles Crane & Hoist Corporation, motor hoists.
Skilsaw Company, electric saws.
Signode Steel Strapping Company, steel box strapping.
Society of Industrial Engineers—time study equipment.
Standard Oil Company (Indiana), industrial lubricants.

Tablet & Ticket Company, tickets and tablets for production control.
Temporator Company, centralized automatic production control equipment.
Texas Company, oil and grease lubricants.
Toledo Scale Company, industrial scales.

U. S. Department of Labor, first aid supplies and safety posters.

Waste Elimination Committee of A.S.M.E., exhibits of several waste elimination campaigns.
Webb, Jervis B., Company, conveyor chain.
Weber Insulations, Inc., heat insulating materials.
Wellington Machine Company, industrial trucks and casters.
West Bend Equipment Corporation, shop furniture, benches, and hand trucks.
Western Bearings Company, ball and roller bearings—radial and thrust.
Western Pipe & Steel Company, steel trucks and platforms—Fishoilene (a rust preventive).
Whitehead & Kales Company, gasoline tractors.
Whiting Corporation, traveling cranes.

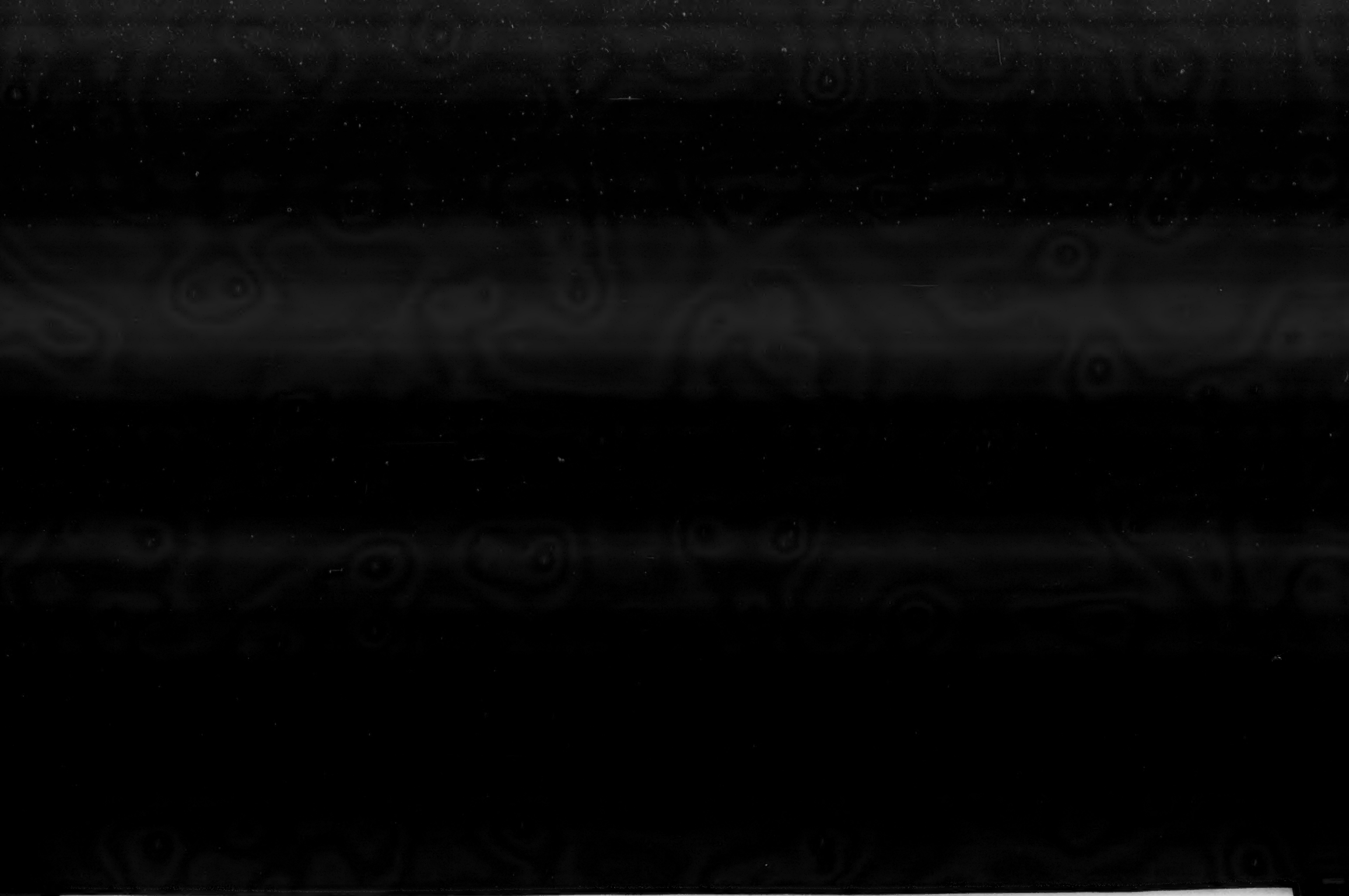
Centennial of Weighing

THIS year is the centennial of weighing. It was in 1830 that Thaddeus Fairbanks invented the platform scale. His doing so resulted from the "hemp craze" which struck Vermont. Thaddeus Fairbanks conceived the idea of supporting the platform, upon which the hemp was to be weighed, upon an A-shaped lever with the tip of the lever connected to the steelyard by a rod.

The same inventor received in 1857 the United States patent for the railroad track scale.

The type-registering beams were brought out in 1900. They are still extensively used in elevators, rolling mills, refineries, steel plants, and railroads.

In 1913-14 the plate fulcrum principle in scale construction was applied to railway track scales. Its inventor was A. H. Emery.

Self-indicating or dial machines have been the most recent development even though Leonardo de Vinci, who lived in the 15th century, is credited with their invention.

What is said to be the world's largest scale was built recently at the St. Johnsbury factory of Fairbanks, Morse & Co. It is located at the plant of the Hamilton Furnace Company at Hamilton, Ohio. This scale weighs a loaded mixer, weighing a million pounds which is six times the weight of a loaded coal car.